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Africa/Europe/Middle East
The role of ICT

Category 3

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Teacher Training Workshop

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The International Baccalaureate aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect.

To this end the organization works with schools, governments and international organizations to develop challenging programmes of international education and rigorous assessment.

These programmes encourage students across the world to become active, compassionate and lifelong learners who understand that other people, with their differences, can also be right.

Workbook contents

Schedule for IB workshops in June 2014

Monday, June 23

8:30 – 10:00	Session 1
10:00 – 10:30	Refreshment break
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12:00 – 12:45	Lunch
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14:35 – 16:05	Session 4

Tuesday, June 24

8:30 – 10:00	Session 5
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12:45 – 14:15	Session 7
14:15 – 14:35	Refreshment break
14:35 – 16:05	Session 8

Wednesday, June 25

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NB: Participants who attend all sessions of the workshop will receive a certificate of attendance.

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Primary Years Programme

The role of ICT in the PYP

June 2011

PYP131

The role of ICT in the PYP

This document clarifies the role of information and communication technologies (ICT) in IB World Schools offering the Primary Years Programme (PYP), and should be read in conjunction with *Making the PYP happen: A curriculum framework for international primary education* (2009).

Beliefs and values about ICT in the PYP

The ever-increasing impact of ICT on teaching and learning is an important consideration in education at all levels. Through ICT, there are greater opportunities for interactive communication and exchange of information through global collaboration, authentic learning, expansion of the learning community and empowerment for all learners.

ICT in the PYP encompasses the use of a wide range of digital tools, media and learning environments for teaching, learning and assessing. ICT provides opportunities for the transformation of teaching and learning and enables students to **investigate**, **create**, **communicate**, **collaborate**, **organize** and **be responsible** for their own learning and actions. ICT allows students to make connections and reach a deeper understanding of its relevance and applicability to their everyday lives. Through the use of ICT, learners develop and apply strategies for critical and creative thinking, engage in inquiry, make connections, and apply new understandings and skills in different contexts.

In this constantly evolving digital age, ICT is progressively becoming a ubiquitous part of a learner's life at school and beyond: for learning, working, innovating, creating, responding, problem-solving, problem-posing, socializing and playing. Students inhabit a world saturated with information, images and sound. Inevitably, students' immersion in this world continually leads them to explore creative and innovative uses of emerging technologies beyond their basic functional applications, discovering new ways of engaging with content meaningfully, and participating fully in today's world.

The IB learner profile is integral to teaching and learning in the PYP because it represents the qualities of effective learners and internationally minded students. The learner profile, together with the five essential elements of the programme—concepts, knowledge, skills, attitude and action—inform the integration of ICT in planning, teaching and assessing in the PYP.

The role of ICT in a transdisciplinary programme

In the PYP, it is advocated that purposeful inquiry is the best way to learn. The starting point should always be students' prior experiences and current understanding. When teachers plan learning experiences that enable students to develop, students are able to make connections, apply their learning, and transfer their conceptual understanding to new situations. This progressive conceptual development, together with an enjoyment of the process, provides the foundation for lifelong learning.

In the PYP, there will be opportunities to use ICT in the relevant, authentic context of the units of inquiry, as well as through teaching and learning experiences in other areas of the curriculum. Teachers have a responsibility to help students to make explicit connections between different aspects of their learning. Students need opportunities to identify and reflect on significant ideas within the different skills of ICT, the transdisciplinary themes, and other subject areas. The role of ICT to support inquiry is important as students engage in building understandings that contribute to their success as lifelong learners in a digital age.

To ensure a cohesive educational experience for students, a PYP school is responsible for ensuring that there are regular opportunities for collaboration among teachers in the school including homeroom/classroom, single-subject and support teachers (for example, teacher-librarian, ICT teacher, learning and/or special needs teacher). This collaboration includes the development and overall review of the school's programme of inquiry, as well as planning, teaching and reflecting on individual units of inquiry. However, it should be recognized that the responsibility for learning about and through ICT is shared among all teachers. It is acknowledged that in many schools, a single-subject teacher takes responsibility for ICT. It is vital that these teachers see themselves primarily as PYP teachers who teach and integrate ICT throughout the curriculum, and in so doing contribute to both the broad and specific learning outcomes of a transdisciplinary programme.

It is worthwhile to note that there will be opportunities for student-initiated, spontaneous inquiries into the use of ICT that are not directly related to any planned units of inquiry or single-subject areas. For example, a student contributing to a class blog may want to start his or her own blog as a personal reflection journal. These are valuable teaching and learning opportunities in themselves, and provide teachers and students with the opportunity to apply the pedagogy of the PYP to authentic, of-the-moment situations.

ICT skills for inquiry

The effective integration of ICT enhances the learner's opportunity to connect globally and to explore different perspectives in order to understand evolving cultural and social norms. The following list of ICT skills provides the whole school community with a structure for using ICT as a tool for learning. It has been designed in recognition of the fact that learning is a series of feedback loops involving the individual, the group and the local or global environment. All teachers working with PYP students will find that the ICT skills will be relevant to the transdisciplinary programme of inquiry as well as to subject-specific inquiries.

ICT includes a variety of approaches to help connect learners within both the local and global community in order to empower learning. Learners' awareness, use and appreciation of different ICT knowledge, skills and platforms should be developed. Furthermore, students should be encouraged to recognize that competency in ICT is a valuable life skill.

The following six ICT skills are relevant to all learners: investigating, creating, communicating, collaborating, organizing and becoming responsible digital citizens. Each skill is transdisciplinary and will support learning both within the transdisciplinary programme of inquiry and within the subject areas. These skills interact with each other to support the development of learners. Therefore, teachers should consider these skills when planning for teaching and should look for evidence of them in student learning.

Investigating

Investigating is to carry out a purposeful inquiry or research, to test existing understanding, discover new information and create new understanding. Through investigation, learners critically evaluate a variety of sources, making connections and synthesizing findings to apply knowledge to real-life contexts.

Creating

Creating is a process through which learners are provided with an opportunity to innovate and test boundaries. Learners construct meaning, apply critical thinking and original ideas to real-world situations, and share knowledge through self-expression, problem-posing and problem-solving, and reflection.

Communicating

Communicating is the exchange of information with various audiences using a range of media and formats. Effective communicators contribute to cross-cultural understanding, make informed choices when deciding on tools to articulate meaning, and provide relevant, significant feedback to others.

Collaborating

Collaborating is the process through which learners validate and negotiate ideas and reach a deeper understanding and a global perspective. Learners are empowered through digital media and environments and through active participation in creating and sharing knowledge.

Organizing

Organizing is the ability to structure or arrange connected items. Learners understand that ICT systems can be used to inform, adapt, manage and problem-solve during their creative, communicative, collaborative and investigative processes. Learners make connections, transfer existing knowledge and independently explore new technologies.

Becoming responsible digital citizens

Becoming a responsible digital citizen involves using ICT to make informed and ethical choices while acting with integrity and honesty. In a globally connected digital world, learners are empowered to be responsible for their actions, to value others' rights and to practise safe and legal behaviours.

The suggested ICT skills above are not an added layer to the existing PYP skills as documented in the *Making the PYP happen: A curriculum framework for international primary education* (2009). Rather, they reflect the IB learner profile and the five essential elements of the PYP—concepts, knowledge, skills, attitudes and action. The ICT skills have a role to play in all these aspects of the PYP curriculum model: the written, taught and assessed curriculums. In particular, the ICT skills listed should be cross-referenced with the five transdisciplinary skills defined in the PYP: thinking, social, communication, self-management, and research skills. The ICT skills defined in this document should be seen as supporting and contributing to the existing PYP essential elements.

Good ICT practice

ICT is one of the connecting components throughout the curriculum. As students engage with ICT across and between the transdisciplinary themes and subject areas, they come to a deeper understanding of its relevance and applicability to their everyday lives. Appropriate attitudes and behaviours concerning the use of ICT are also modelled within the school community.

In a PYP school, the focus of ICT is not only on the use of technology for its own sake, but to enhance learning throughout the transdisciplinary programme of inquiry, across the subject areas, the IB learner profile, and the essential elements of the PYP. It is clearly a transdisciplinary strategy. The understanding and effective use of ICT has moved beyond simply mastering a specialized set of skills and tools: ICT has become a vehicle for learning skills and concepts and their applications within meaningful contexts. The role of the school and teacher is to create authentic learning engagements through the provision and use of ICT. This learning can happen in a physical or a virtual environment, and is likely to occur when needed or "just in time".

All teachers are responsible for using ICT to its best effect throughout the curriculum. This integrated approach, to support teaching and learning using ICT, provides opportunities for consistent and coordinated practice that can be communicated, understood and undertaken by the whole school. In this way, all stakeholders may function as partners in education, making learning more relevant and enduring for the student. In order for effective integration to take place, the school needs to plan collaboratively what form this integration will take, guided by the school's beliefs and values about ICT and the PYP stance on how students learn best.

Teachers' competence in the use of ICT is of key importance. What experiences teachers have had will shape their choices of resources, the learning experiences they design and how effectively they are able to support the development of each student's understanding. Teachers' interest in, and development of, ICT should be

maintained through regular professional development, reading of professional journals and regular contact with educators in professional learning networks who share their commitment to the integration of ICT in the curriculum.

Teachers can use the eight PYP key concepts—form, function, causation, change, connection, perspective, responsibility and reflection—to guide their own inquiries. By engaging in inquiry themselves, teachers will achieve a deeper understanding of the role ICT plays in learning and in society, and will also be models for their students by demonstrating that they too are learners.

ICT in a PYP school should be about more than using hardware and software. Its purpose should be to develop a combination of transferrable skills and understanding so that students can actively participate in a digitally connected world. Schools should be aware that many students are confident users and explorers of ICT. Teachers should find out what students already know and can do so that they can teach appropriate knowledge and skills and develop students' understanding. This will enable the students to be discerning producers and consumers of content and tools. Therefore, ICT should support specific learning opportunities such as:

- investigating and carrying out a purposeful inquiry
- creating and innovating
- communicating and exchanging information with varied audiences using a range of media and formats
- collaborating by actively participating in creating and sharing knowledge
- organizing and understanding that ICT systems can be used in various ways
- becoming responsible digital citizens who make informed and ethical choices, while acting with integrity and honesty.

The school's pedagogical leaders play a vital role in the successful use of ICT throughout the curriculum. The effective use of ICT in teaching and learning will have a profound impact on schools in areas such as resourcing, staffing, professional learning, classroom structures and the definition of the learning community. Preparing PYP students for today's and tomorrow's world by enhancing teaching and learning through ICT will depend on the support and, more importantly, the understanding and involvement of the school's leadership team.

A PYP classroom can be connected to the broader world through ICT. Students research and communicate not only through printed media but also through global electronic networks in order to access a vast range of multimedia resources. ICT provides a platform for learners to engage with the world and, in an IB World School, to relate to, and accept responsibility for, the mission of the IB to "help to create a better and more peaceful world". Through ICT, students learn what it means to be a participant in a global community, to be digitally responsible and to make informed reflective decisions.

How ICT practices are evolving

The PYP represents an approach to teaching that provides a context within which a wide variety of teaching strategies and styles can be accommodated, provided that they are driven by a spirit of inquiry, promote conceptual development and have a clear sense of purpose. Structured, purposeful inquiry is the main approach to learning about, and learning through ICT in the PYP.

The degree of change needed to integrate ICT both for and through inquiry will depend on individual teachers' understanding of the role of ICT in the PYP, school policies and resources, and collaboration among teachers. Teachers should engage in reflection on their own practice, both individually and in collaboration with colleagues, with a view to sharing ideas and strengths, and with the primary aim of improving their teaching to improve student learning. In doing so, they will be modelling the skills and attitudes that have been reflected in the IB learner profile.

As an aid to reflection, the following set of examples of good ICT practice has been produced. It is believed that these examples are worthy of consideration by anyone committed to continual improvement of practice.

Increase emphasis on:	Decrease emphasis on:
concept-driven and transdisciplinary teaching taking place both inside and outside the programme of inquiry	teaching an isolated subject or topic
using ICT to investigate, create, communicate, collaborate, organize and be responsible digital citizens	learning ICT as a series of skill sets for their own sake
authentic embedding of ICT across the curriculum	stand-alone ICT lessons
viewing teachers and students as collaborators in the learning process	viewing the teacher as the sole deliverer of skills and knowledge
providing opportunities for student choice to encourage students to take responsibility for their learning	using specific ICT tools exclusively for particular tasks
learning as part of a broader community of learners	learners learning in isolation as a dominant feature
adapting multiple systems or approaches (for example, platform or application) according to the situation and needs of learners	reliance on one system or approach (for example, platform or application)
collaborative planning and reflection	planning for ICT instruction in isolation
professional learning as a continual process	professional learning as a one-time event or opportunity
professional learning provided within authentic contexts	stand-alone professional learning
learning beyond the classroom through global connections	learning restricted to the classroom or ICT lab
management of ICT resources to meet educational goals	management of ICT resources without strategic planning
publishing content for an authentic audience, for example, using social media tools to communicate a message to a wider group of people.	printing student work for display on the school bulletin board only.

Developing an ICT policy: A sample process

A PYP school community should collaboratively identify and agree on the need for, and aims of, the use of ICT. To this end, schools may want to consider the development of a policy or an agreement that defines their beliefs and values, as well as operational guidelines in relation to ICT. This should reflect the mission of the IB and that of the school, and be reviewed regularly to reflect the constantly changing nature of learning and ICT. It must be communicated effectively to all stakeholders. All school decision-making related to ICT should be guided by the school's ICT policy.

Every school exists within a different context, which must be taken into consideration when the school determines how best to develop and improve its ICT policy.

The following organizational process is a sample that schools may choose to follow or adapt in order to develop and strengthen their own ICT policy.

Stage 1: Form an ICT committee

Different stakeholders in the school community could be members of an ICT committee. However, it is essential that the pedagogical leaders of the school are members of this committee as they are responsible for the effective management of resources (people, time, equipment and money).

Stage 2: Conduct an ICT review

The committee should conduct a strategic review of the current state of ICT at the school, including:

- ICT philosophy
- the role of ICT to support teaching and learning
- the position of ICT in the curriculum
- organizational structures and staffing
- management practices
- resources and budget
- professional learning
- existing policies and procedures.

Stage 3: Define beliefs and values

The committee should collaboratively develop a document that defines the school's beliefs and values, as well as operational guidelines, in relation to ICT. This should be aligned with the IB's mission statement and the ICT belief and value statement as represented in this document. While engaging with this process, the following questions may facilitate discussion.

- What role does ICT play in developing the essential elements of the programme and the attributes of the IB learner profile?
- What does the integration of ICT across the curriculum look like?
- What does the school believe is an adequate provision of resources?
- How will ongoing professional learning in the use of ICT be valued in the school?
- What are the different roles and responsibilities of members of the school community with respect to ICT provision and use?

The committee should obtain feedback from the school community about the draft document and use this input to make revisions as needed.

Stage 4: Develop an action plan

The committee should develop an action plan with clear goals and strategic processes to meet the needs outlined in the school's beliefs and values about ICT document. While developing this plan, the following questions should be taken into consideration.

- How does the school's ICT policy make the ICT skills operational (for example, investigating, creating, communicating, collaborating, organizing and becoming responsible digital citizens)?
- How can ICT be used to enrich and differentiate learning experiences?

- What ongoing professional learning in the use of ICT will be provided for staff?
- How will the school evaluate the effect of ICT on learning?
- What types of organizational structures are needed to support effective and authentic provision and use of ICT across the curriculum?
- What sustainable management practices (for example, ongoing professional learning, hardware replacement) will make the school's beliefs and values about ICT operational?

The committee should obtain feedback from the school community about the action plan and use this input to make revisions as needed.

Stage 5: Implement

The committee should establish a timeline for implementation and ongoing review of the action plan and communicate the plan to the school community.

Learners of today and tomorrow

The IB offers schools programmes that promote the development of "inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect". The emergence of educational technologies has transformed how IB World Schools achieve this mission.

In particular, the internet, one of the greatest technological innovations in the last 50 years, facilitates the finding and creating of information, as well as building and maintaining relationships and communities. Students of today are raised in a connected world and their immersion in wired technologies contributes to the evolution of learning in digital spaces. A new dynamic educational landscape has emerged. It is, therefore, critical that students' awareness, use and appreciation of different kinds of information, skills and platforms should be developed both at school and at home. The school community should be engaged in a dialogue to ensure a positive educational experience by understanding how to use the internet and web-based devices safely, responsibly and smartly.

> The work done by curriculum developers of this document was undertaken without prejudice, in that the review work was not a deliberate attempt to align with PYP core documents. Consequently, it is particularly interesting to note that the ICT skills defined in this document are reflected, either explicitly or by extension, in the PYP transdisciplinary skills listed in *Making the PYP happen: A curriculum framework for international primary education* (2009).

Samples

A range of related sample materials aimed at illustrating how PYP schools view, consider, and plan for ICT in their school can be found in the HTML version of this publication. The IB is interested in receiving more related sample materials, in particular materials that show how schools are using information presented in this publication to support teaching and learning. Examples of materials include:

- ICT policies
- planners where ICT skills are used to support inquiry
- planning documents that show the connection between ICT and the curriculum
- job descriptions outlining the role of the ICT teacher in a PYP school.

PYP schools willing to share their work should send these materials to a wiki that has been set up to support this publication, http://ict-pyp.wikispaces.com/, or to pyp.curriculum@ibo.org.

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Bickley, M and Carleton, J. 2009. "Students without borders." Learning and leading with technology. Vol 37, number 3. Pp 20-23.

By Mali Bickley and Jim Carleton

Students Without Borders

Global Collaborative Learning Connects School to the Real World

Teachers from middle school on up are familiar with the complaints of students questioning the need for instruction they think they'll never use once they get out of school. In contrast, lessons that have an obvious practical purpose or, better yet, make a clear difference in the real world right now, seem to make sense and to engage their interest.

Using information and communication technology (ICT), such as Web conferencing and wikis, to connect students to their peers in other countries and cultures is one way to engage our students. But it's not just about technology. Global collaborative learning is about connecting students in communities of learners around the world so they can work together on projects that make a difference locally and globally. It is about building relationships and achieving authentic, meaningful learning. And it lends purpose to lessons and drives just-in-time learning for teachers as well as students as they become co-learners.

Organizations such as the International Education and Resource Network (iEARN) and TakingITGlobal facilitate collaborative partnerships between classrooms, students, communities, and educational partners around the globe. These projects use ICT to help students work together to accomplish meaningful tasks, solve problems, and learn new perspectives from their peers. Creative processes that allow for a grassroots style of learning and questioning enrich students' critical thinking skills. What better way to learn about such difficult subjects as war, natural disasters, child soldiers, and segregated education than from other students who are involved? They learn *with* the world rather than just *about* the world.

New Perspectives

The Machinto Project is a K–12 literature-based iEARN program that draws inspiration from the Japanese picture book *Machinto*, which is about a 3-year-old girl who is outside playing in Hiroshima, Japan, on the morning of August 6, 1945. She is tragically killed by the atomic bomb but is

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Third and fourth grade students from Yasutomi North Elementary School in Hyogo-ken, Japan, collaborated with Canadian students on a mural depicting what each learned about an environmental issue in its partner's country.

resurrected as a peace dove that brings hope to other children in the world who are affected by war.

Students learn about how war affects children their own age in the past as well as in the present day. They also read other books with a similar theme, such as *Sadako and the Thousand Paper Cranes* and *Peace Crane*, and learn to make both text-to-text and text-to-world connections.

The culminating task for the project is the creation of a picture book with the theme of peace and friendship. Every participant makes his or her own book to publish on the Machinto website. The program also sends the collection of books to children in war-affected areas of the world as a gift of friendship from the project participants.

This year, our students created picture books about how they imagined peace and sent them to a school in Kandahar, Afghanistan. The amount of work, care, and thought the students put into their writing and artwork showed the depth of connection they had to the project and to their peers in Afghanistan.

Because real children and real-world issues are part of the project, the tasks they perform become incredibly engaging and inspiring.

Machinto participants located at schools throughout the world had the chance to meet each other during a live Web conference. They participated in a literature circle during a virtual class-to-class meeting and shared their stories, poems, and artwork in a "classroom without borders" with peers from Canada, Taiwan, Japan, Mali, and the United States. It was a life-changing experience for both the teachers and the students involved, as having that personal connection to others reinforced the relationships they developed through the project.

The Machinto Project's collaborations open up dialogue about issues that are normally not discussed in elementary school classrooms, and in the process, students get to experience discussions and friendships that reach well beyond the walls of traditional learning. Because real children and real-world issues are part of the project, the tasks they perform become incredibly engaging and inspiring.

Our students were able to ask others who lived in war-affected countries what it was like to live in such challenging situations. Last year's partners included participants from Palestine and Israel, where students were able to communicate with others in the Gaza strip while a conflict was occurring there.

The students get to view each other through a different lens than if they had been left to learn about each other through contemporary media alone. One student articulated her feelings about the project in a profound way: "Before the Machinto project, I never gave the war much thought. Now that I know someone living in those situations, I feel compassionate toward them." This kind of character development, though immeasurable, is an invaluable learning experience.

Collaboration across the Curriculum

You can integrate global collaborative projects into all curriculum areas, so they aren't just time-consuming add-ons, and they meet curriculum standards in all subject areas. For example, one project that fits many K–12 curriculum strands is the My Hero Project.

At the My Hero website, students can publish essays about their heroes for a global audience. Entire classes can also participate in the project within a formal global "Learning Circle" of six to eight classes from countries all over the world.

A project facilitator coordinates activities for all of the classes in the circle. Each class is responsible for completing and posting class interest surveys on group forums, sending welcome packages to the other classes in their circle, and participating in online circle discussions about their heroes.

Students research and write about a hero in their lives using a structured writing-process tool and create a webpage about the hero with publishing tools (found on the eCreate page of the My Hero site). These tools enable

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Knowing that their stories are to be part of a worldwide project and having the ability to share their work are huge motivators for many reluctant writers.

students to include pictures, Web links, bibliographies, and quotations. At the end of the project, each class has a professional-looking webpage that features My Hero stories from each participant.

Knowing that their stories are to be part of a worldwide project and having the ability to share their work are huge motivators for many reluctant writers. In fact, we have seen students who had never before finalized a piece of written work produce an inspiring My Hero story.

Students can also produce short films about their heroes. Several fourth grade students from W. H. Day Elementary School in Bradford, Ontario, Canada, wrote, filmed, produced, and edited a short film about their hero, Mohamed Sidibay, a former child soldier from Sierra Leone they had supported and communicated with for several years. They submitted the final product to a national Canadian multimedia competition and won first place in the elementary school category for their film.

These projects also allow for differentiation within the summative and assessment pieces while encouraging all participants to reach their potential. We encourage teachers to participate in the My Hero project as a springboard to integrating technology into their classrooms while participating in collaborative learning, as the project is so successful with students of every age group.

Artful Connections

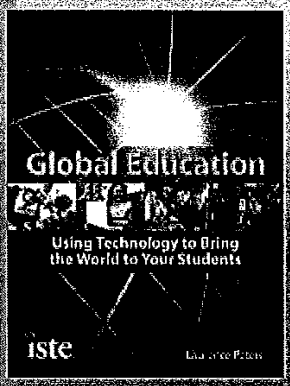
The Art Miles project is a collaborative global project that helps geographically distant K–12 classes learn about a specific aspect of each other's country. This year, several classes from Japan partnered with classes from Canada, Indonesia, Russia, Vietnam, Italy, and Fiji. As the program expands, other countries will be added as partners, including Romania and the United States.

The students' primary job is to teach their partners about a specific aspect of their own country or culture. Each class begins their participation by preparing and sending a welcome package of gifts from their culture to introduce their community to the other class. The students put a great deal of thought and effort into this package. Our Ontario class sent Canadian flags; maps; hockey cards; maple syrup; a small Canadian sweater; a variety of Canadian tales, such as "The Paper Bag Princess;" and information about an environmental issue in our region. In return, our Japanese partners sent origami paper, Japanese cartoons, Japanese games, and books that

Canadian fourth graders sent their handmade books about peace, inspired by the Japanese picture book *Machinto*, to students in the war-affected town of Kandahar, Afghanistan (left). Student-created paper cranes were dedicated in the name of peace at the Hiroshima War Memorial in Japan (right).

Learn More about Global Collaborative Learning

For more ways to engage students with the real world while teaching them about the curriculum and other cultures, tune in to the ISTE webinar "Learning WITH the World: Using Technology to Connect Students Globally in Project-Based Learning." In this presentation, available at www.iste.org/webinars, Mali Bickley and Jim Carleton give educators more examples of projects that teach higher-order and critical-thinking skills while helping students develop real and meaningful relationships with their peers around the world.



ISTE also recently released the book *Global Education: Using Technology to Bring the World to Your Students*. Author Laurence Peters explains how to integrate global collaborative projects into your curriculum using Web 2.0 tools and existing global networks such as iEarn, Global Schoolhouse, and ePals, supported by case studies, lesson plans, and hundreds of resources for bringing global education opportunities to students of every subject area and grade level. You can find *Global Education* at the ISTE Bookstore (www.iste.org/bookstore).

—Megan Dolman, Books Sales & Marketing Specialist, ISTE

Bickley, M and Carleton, J. 2009. "Students without borders." Learning and leading with technology. Vol 37, number 3. Pp 20-23.

Fourth grade students at W. H. Day Elementary School in Bradford, Ontario, Canada, wrote, filmed, produced, and edited a short film about their role models to share with peers around the world through the My Hero Project.

depict the Japanese culture and environment. Each class also prepared a short video that gave a tour of their school and community.

The students communicated through a wiki, where they posted photos, told stories, and planned their final collaborative task, painting a 12-by-5-foot mural. For their part of this task, the Japanese students painted half of the mural about what they learned about the Canadian environmental issue. They then shipped the mural to us, and we completed it based on what we learned about the Japanese environmental issue. The end result was a truly inspiring depiction of an important part of each country's environment, a symbol of the classes' collaborative relationship, and a demonstration of how technology can seamlessly integrate science, art, and literacy while celebrating cultural diversity through the universal language of art.

We will display the mural around our community before it goes back to Japan to be part of the Japanese students' graduation ceremony. From there, it will become part of a traveling art exhibit that will be displayed at major art galleries throughout the world before ending up in an exhibit with 5,000 other Art Miles murals at the Great Pyramids in Giza, Egypt, to celebrate the end of the UNESCO Decade of Peace in 2010.

We encourage teachers who have been participating in global collaborative learning projects to mentor and support other teachers who are beginning the journey of integrating such projects into their programs. It may take more energy to plan for these learning experiences than traditional, hierarchical, top-down learning, but that model was better suited for the Industrial Age. Once we saw how these projects engage students and effectively teach 21st-century skills, we knew we had a responsibility to continue teaching with them. We also knew that we had to showcase our students' work—work that is powerful and moving and speaks to our common humanity—so that administrators and parents can see how ICT changes the way we teach and learn as well as how we engage our students to be responsible and literate citizens in a global information society.

Resources

Art Miles project: www.art-miles-project.com
International Education and Resource Network (iEARN): http://iearn.org
Machinto project: www.machinto.org
My Hero project: www.myhero.com
TakingITGlobal: www.tigweb.org

Mali Bickley has been a classroom teacher for 27 years. She integrates technology into her classroom program to connect her students to global partners as they work together on projects that make a difference.

Jim Carleton is an ICT consultant for the Simcoe County District School Board in Ontario, Canada. He is a strong advocate for using new and emerging technologies in ways that inspire students and teachers.

By David and Margaret Carpenter

All Aboard!

How a New Curriculum-Development Review Process Brought Teachers, Administrators, and Learning Specialists to the Table and Resulted in Some Innovative Uses of Technology

Instructional technologists can succeed in implementing 21st-century skills instruction only when those skills are seen as relevant to the pressing agendas that coexist in their schools. Otherwise they run the risk of being just more noise that teachers must respond to and may filter out. So how can they be seen as part of the solution instead of another nagging problem?

At Hong Kong International School (HKIS), technology instruction gained traction when it was addressed alongside several curriculum initiatives. Here's how a new curriculum-development review process resulted in some innovative uses of technology in the classroom. (See "Key Elements of the New Curriculum Process" on page 19.)

Putting Teachers in Charge

Teachers at the Upper Primary division of the HKIS felt they were inundated by the demands placed upon them by their students, parents, administrators, and subject-area specialists. Rather than letting teachers drown in these demands, school administrators put teachers at the center of the curriculum-development process. They designed a system that harnessed the talents and time of various stakeholders through a carefully orchestrated collaborative process.

Teachers, learning specialists, and administrators comprised the Collaboration Team based on the idea that everyone should participate and "own" the curriculum. This learning community approach, with designated classroom teacher leaders representing their grade-level teammates, put the teachers in charge of the process. Also, from the outset, it put them in conversation with the instructional technologist, the library media specialist, and the gifted-and-talented coordinator.

The inclusion of the instructional technologist and library media specialist as partners on the Collaboration Team dynamically moved the process to focus on 21st-century skill adoption. Because these two specialists serve all grade levels, their perspective on next-step skills needs was invaluable to the classroom teachers, whose focus was naturally more grade specific. Their input and leadership regarding instructional design and adoption of the NETS and ALA standards led to seamless integration of information and communication literacy (ICL) skills into the social studies and science units of study.

Administrators and the curriculum director facilitated efficient, collaborative discussions that focused on a few standards and essential questions, making the assessments uniform and providing options for differentiation, many of which were possible with the technology support. Having so many perspectives helped eliminate redundancies as well as build upon students' skills sequentially.

Getting Started

By zeroing in at the start just on the social studies and science units, with reading and writing to come later, the teachers gave themselves a manageable task. Deciding not to take on too much at one time naturally led to more buy-in. By giving teachers classroom coverage for the half- and full-day meetings, the school principal validated the process while avoiding the usual rushed-through after-school meetings.

A second driver for ICL integration involved the use of a versatile online curriculum-mapping tool that contained a unit-planning template. That template is structured to prompt users to add specific instructional strategies and assessments enhanced by technology use.

Much thought went into designing the unit-planning template, as it also guided the Collaboration Team to differentiate the content, process, and student learning products.

The template design originated from the Understanding by Design (UbD) sample templates provided by Jay McTighe and Grant Wiggins in their *Understanding by Design Professional Development Workbook*. In the case of the HKIS, the online curriculum-mapping tool is one part of the myDragonNet virtual learning environment that also provides a classroom management system as well as electronic portfolios for students and teachers. (See *L&L*, "Breathing Fire into Web 2.0" by Justin Hardman and David Carpenter, February 2007.)

In their annual review of the process, collaboration teams base their discussions on the success of past assessments (Did students learn what we intended for them to learn?) and comment on how the essential questions, instructional strategies, and assessments often needed further refinement and crafting. New teachers are brought into the process to benefit from the talents and ideas they contribute while orienting them to the curriculum that's been adopted.

KEY ELEMENTS OF THE NEW CURRICULUM PROCESS

- Best practices for instructing 21st-century students in a standards-based school
- Assessment-driven curriculum improvement
- Differentiation for gifted as well as struggling students and various learning styles
- Integrated technology and information literacy skills
- Curricular decision-making documentation to meet the needs of various audiences (especially teachers new to the school, administrators, parents, and students)
- Expansion of the Collaboration Team to include learning support, ESL, and other specialists to further design the curriculum to meet the needs of all students

Working Together

The instructional technologist and library media specialist were already versed in the unit goals because they were on the Collaboration Team and helped to write the instructional materials. That made it easy for them to codesign the lessons they delivered to the students to support the science and social studies units.

The impact of integration and collaboration was immediate, grade-wide, and articulated from grade level to grade level:

- Third-graders enjoyed a "BuddhaQuest" designed by the librarian to explore Internet-based sound-recordings, images, and text about Buddhism while also learning terms associated with using the Internet (e.g., URL, menu, browser window, server). The instructional technologist supported this short inquiry project on Buddhism by teaching the third graders how to use Inspiration. Students were able to record and pursue their individual questions, capture images, credit sources, and paraphrase findings through their mind maps. Classroom teachers used the tool to pose probing questions based on individual webs.
- For their nutrition unit, fourth graders shared and compared recordings of their eating habits by adding daily to a class wiki in their Moodle course sites. The development of library lessons on asking good research questions, note-taking, using subscription databases, and citing sources tied directly to the fourth grade's essential questions.
- For fifth grade inquiry projects, the WebQuests that were developed integrated the next stage of ICL instruction. Teachers reinforced prior skills instruction and added the next layer—Web site evaluation and visual literacy lessons—as they shot and incorporated meaning-making images into their photo essays.

For these units, the librarian and literacy coordinator purchased and recommended book sets for "leveled reading" in classroom readers' workshops.

Thanks to the improved understanding of assessments, the media specialist was able to supply resource teachers with DVDs to scaffold instruction to their charges.

The gifted-and-talented instructor conducted pull-out literature circles on advanced-reader novels that directly supported the themes and essential questions explored by all students at grade level. Thus, those gifted students received enhanced work rather than just

more work. These are a few examples of the ways that the improved curriculum-writing process integrated the efforts of specialists to improve instruction, co-teach lessons, develop and purchase resources, design assessments, and enhance students' learning in all classes across all grade levels.

Learning Alongside Students

On another level, classroom teachers learned new technology and information literacy skills alongside their students. Teachers became emboldened to ask, "Where else can we employ new technology for more dynamic learning?" It didn't take long before teachers began to improve and adapt the integrated technology to new learning situations. Fourth and fifth grade teachers were eager to use video cameras, Photo Story, Inspiration, Moodle, and other tools because their students were already familiar with them. They saved class time because they didn't have to teach students how to use the technology.

Here are some examples of how teachers adapted their lessons:

Podcasts. Using Audacity to create podcasts for end-of-unit social studies assessments gave Ben Hart, a grade three–four combo teacher, the idea to use the same technology to have his students record reflections from their writing conferences. Hart prompts his students to record their thoughts about how they are improving their use of the writing process, what they are working on as writers, and the next steps they plan to take. It provides him with instant feedback as he listens to the sound files from the writing conferences.

Mind maps. David Navis, a fifth grade teacher, has expanded upon how Inspiration mind maps are integrated into the social studies and science units of previous grades. Students are provided a mind map template with the essential questions for the various units. They start the units with a pre-assessment and respond to the essential questions by adding new concept bubbles to demonstrate their expanding understanding. As the school emphasizes inquiry, the students add any questions that come to mind in the "parking lot" section of the mind maps. As the units progress, students continue their reflection to further develop their responses to the questions.

Navis has students use set colors for their new concept bubbles at each stage of reflection (blue symbols for the start of the unit, gray for the middle, green for the end of the unit) to push the process to deeper student reflection and learning. Navis says, "Once the diagram is complete, I switch to outline form on the class projector using an example from one of my students with his/her permission. It becomes very evident how their

If your curriculum-development system is not driving how you do business at your school, think about what steps and stakeholders need to be involved to redesign and then participate in creating, sequencing, communicating, and assessing your curriculum.

thinking and knowledge has expanded. The next step is to have them write an essay from the outline."

Multimedia presentations. With all of the students doing research for a Civil War Unit common assessment, Gene Cheh, a fifth grade teacher, did his own exploration and multimedia creation expanding upon the initial information literacy research skills integrated into the unit. Cheh used Flash to construct a slideshow of primary-source posters for the students to interpret using visual and information literacy skills. Gene used clickable "hot spots" on the poster images that provided probing questions for his students' reflection.

Reflecting on the Process

The final stage of the curriculum-review model is the end-of-unit reflection meeting, which has multiple purposes: sharing and reviewing student assessments, selecting and uploading to the curriculum-mapping tool the exemplars to serve future instruction, ensuring reflection on what did and didn't work, and ensuring accountability. Administrators working as instructional leaders furnish vital support to these meetings as they use guiding questions to draw out suggestions that will help improve the units in the future. Changes to the unit plan are noted immediately in the myDragonNet curriculum-mapping tool.

Making It Happen

Whether you are taking the first steps to infuse more technology use into your school's classrooms or are planning a major shift in the culture of your school, take a look at how systematic and healthy your curriculum-review process is. If your curriculum-development system is not driving how you do business at your school, think about what steps and stakeholders need to be involved to redesign and then participate in creating, sequencing, communicating, and assessing your curriculum. A vital question is: How well are you avoiding redundancy and providing for growth from one grade level to the next? Integrating the NETS and ALA standards is just the first step as teachers apply technology and information-skills instruction across the curriculum. The ripple effect for introducing 21st-century learning opportunities can become an unstoppable force in your school's learning community.

Resources

"Breathing Fire into Web 2.0," Justin Hardman and David Carpenter, *L&L* (February 2007)

David Carpenter's blog, Lessons Learned: http://lessonslearned.edublogs.org/

MyDragonNet, www.slideshare.net/jaharman/mydragonnet-learning-platformpart-12/

Understanding by Design Professional Development Workbook, Jay McTighe and Grant Wiggins, Association for Supervision & Curriculum Development (2004)

David Carpenter is a humanities teacher and instructional technologist at Hsinchu International School in Taiwan. He and Jeff Utecht put out a bimonthly podcast titled Shifting Our Schools, which can be found at www.sospodcast.org.

Margaret Carpenter has enjoyed developing curriculum as a library media specialist, coordinator of gifted-and-talented programming, and social studies teacher. She has taught in international schools in Hong Kong, Taipei, Saudi Arabia, Scotland, and Cyprus.

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Caught in the Middle

Electronic Portfolios: Integrating Technology for Meaningful Learning

In the Classroom with Bijal Damani

Integrating technology in the classroom can make a vast difference in teaching, learning, and assessment. Being a business studies teacher for grades 11 and 12, I used to receive numerous requests from graduates wishing to have copies of their—as well their peers'—presentations, business plans, case studies, creative advertisements, and other projects. However, it was difficult to preserve every students' projects for future reference.

I began compiling each student's projects and burning them on a DVD for every class. But that did not help much when students wanted something readily accessible from anywhere. Also, collaborating on projects was difficult for students who wanted to work on them during their vacations.

At that time, I came across the blog by Helen Barrett (http://blog.helenbarrett.org), and I felt inspired to create an e-classroom and connect my students' portfolios to it using Google applications. Electronic portfolios, or e-portfolios, allow students to do six Cs: create, collect, connect, collaborate, conserve, and control.

E-portfolios are emerging tools for collecting documents, presentations, videos, photographs, and assessment histories that students prepare and maintain. They can display students' accomplishments, works in progress, and other academic records. Sharing work with peers, teachers, parents, and potential employers—in fact, anyone in the world—is easy with these tools.

I find that using e-portfolios has helped me tremendously in engaging my students in the learning process. Technology gives students opportunities to take ownership of their learning, and showcasing and sharing work with their peers and parents greatly motivates students. From a teacher's standpoint, portfolios help enormously in formative assessment, because evidence collected in them can give a much richer picture of learners' strengths and achievements than a mere test score. (One word of caution for teachers assessing students' portfolios: be clear which competencies you are assessing.)

Using e-portfolios has helped me build my students' confidence with their information and communication technology (ICT) skills, which are crucial at the university level, and also encourages students to reflect on their processes of learning and development. Because e-portfolios are expandable, students can add as many pages as they wish. Plus, the portfolios are easy to update and universally accessible, making them the perfect tool to facilitate student collaborations.

However, e-portfolios aren't appropriate for every classroom. There are potential risks involved in using an e-portfolio system with students; therefore, you should always check your school's policy regarding online protocols. Also, successful implementation of an e-portfolio system requires access to computers and a high-speed internet connection, which may not be available in many developing and underdeveloped nations. And students' ICT skill level plays an important role in their ability to build and maintain these tools.

Starting off can also be time-consuming for teachers as well as students; but once you've overcome any initial teething problems, e-portfolios are really fun to develop and assess. A tip for teachers interested in using e-portfolios is to make one of your own as a model for students. It can offer evidence of your own academic and professional progress as well. EU

Additional Resources

- My own e-classroom, called Masti Ki Pathshala (A Place for Learning That Is Fun): http://sites.google.com/site/bijaldamaniseclassroom

- An archive of my students' e-portfolios: http://sites.google.com/site/bijaldamaniseclassroom/Home/students-projects/projects-of-std--11
- My e-portfolio, an example of a teacher's portfolio: http://sites.google.com/site/bijaldamanisclass
- E-portfolios of my current students in grade 11: http://sites.google.com/site/snk200910/home/students-projects
- Dr. Helen Barrett's E-Portfolios for Learning: http://blog.helenbarrett.org
- ePortfolio Mash Up with Google-Apps: http://electronicportfolios.org/google
- Google site tutorials: www.google.com/nonprofits/sitestutorial.html

Bijal Damani is an 11th and 12th grade commerce and business studies teacher in the Galaxy Education System in Rajkot, India, and has received numerous honors. In 2009, Damani was a winner of the ASCD Outstanding Young Educator Award.

Huber, C. 2010. "Professional learning 2.0." Educational Leadership. Vol 67, number 8. Pp 41-46.

Professional Learning 2.0

Moodle. Wikis. Twitter. Ning. It's a whole new way of talking about professional learning.

Catherine Huber

Three scenarios describe how educators usually share information in schools to promote professional learning.

Scenario 1: The principal finds a great article or book. She creates a routing slip to circulate the information among a select group—or, on a highly ambitious day, among the entire staff. The resource typically ends up either in someone's take-home bag mixed among papers to correct or in a to-do pile, one of many around the room.

Scenario 2: A faculty member attends a conference and hears something that really helps his thinking about his instructional practice. The teacher shares the idea around the lunch table, but in the hustle and bustle of daily life in school, the other teachers have all but forgotten the idea by the time they return to their classrooms.

Scenario 3: The instructional leadership team meets in the spring to plan professional learning for the upcoming school year. The team plans the eight faculty meetings on the basis of what is currently happening in the school. But when the new school year starts, emerging issues in the building throw the plan off schedule, and administrivia, such as compliance training, become the new required elements. Just like last year, the plan that promised eight hours of action-packed professional learning becomes three and one-half hours of polite learning that fails to tackle the really important issues in the school.

False Assumptions about Professional Learning

The sharing of resources in each of these scenarios is certainly well intentioned, but the professional learning that results is neither sustained, targeted, ongoing, nor job embedded. These scenarios speak to models that rely on false, yet culturally embedded assumptions about professional learning.

Assumption 1:
Passing information on is enough.
This assumption considers the principal, coordinator, or superintendent as the key staff member with access to resources to share. The model offers a top-down hierarchy in which the information serves as capital to dole out to those who need it or who are most willing to read or pass on the resource. Rarely does the conversation extend beyond the routing slip.

The model of the administrator as the disseminator and keeper of information is well engrained in most learning organizations; teachers who find a resource don't usually route it on their own. Relying on a single person within the organization to share resources and provide access to information merely pays lip service to professional learning. Principals can say with pride that they share resources—a step in the right direction—but simply passing resources from one person to another rarely triggers the substantive and purposeful conversations that are the heart of professional learning.

Assumption 2:
Insight must come from outside.
This assumption relies on sending staff members outside the school to learn from various experts rather than tapping into the thinking of the educators in the school. It's assumed that staff members will informally share with colleagues the information they have gleaned from these activities; no formal structures exist for discussion or dissemination of this information. Those who hold this assumption don't always value homegrown expertise.

Using these Web 2.0 tools, any member of the learning organization can post information and resources to which everyone has access.

Schools often rely on outside experts to inspire their staff members to think differently about their instructional practices. Although this can be valuable, what if only a handful of staff members hear the speaker and the only outlet for sharing the information is around the faculty lunch table? What if a school never promotes collaboration and conversation among staff members to access their thinking on the topic? What if the school always looks outward, rarely considering internal expertise? How then does the school support new and creative thinking from within?

Assumption 3:
Planning means learning.
This assumption equates professional learning with having a great plan. Even when the plan for learning derails, its creators can say, "But we had a great plan!" This assumption allows professional learning to be cast aside when the school needs time to address more "pressing" issues.

Learning organizations need to develop long-range plans, but they often develop such a rigid plan that it leaves no room to address emerging issues. In addition, the professional development planned for faculty meetings is usually scattered; rarely do such meetings offer the time needed for focused and sustained conversations about teaching and learning. Another drawback of professional learning plans is that because they were developed the previous year, they are typically based on last year's—not the current year's—needs.

Upgrading Professional Learning

Each of these false assumptions takes hold because of a reliance on traditional models for professional development. The school goes through the motions of professional learning, but its approach is based more on the illusion of collaboration than on substantive, ongoing, sustained conversation.

Although traditional learning structures certainly play a role in the learning life of teachers, we need to update the approach. Web 2.0 technologies can help schools create structures for sustained, complex, and meaningful professional learning.

Structure 1:
Share access to information.
A 2nd grade teacher who is establishing a reading workshop in her classroom

needs some suggestions for strong model texts—published pieces of writing whose ideas, structure, or craft can inspire students to write something original. Her district has established a Ning where teachers can post questions. She asks a question there about model texts. Within a few days, she receives some great ideas, titles, and reflections on the topic from colleagues across the district.

The teacher has also sought out blogs by teachers who have developed reading workshops. She gleans some strong titles and good ideas from those sources as well. In fact, she contributes some of her own thinking to the conversation on the Ning forum.

The Web 1.0 mind-set looked at professional learners as consumers of information. Teachers, for example, might go on the Internet to look up content created by someone else. Web 2.0 tools are based on the understanding that professional learners can be both consumers and producers of information. Web 2.0 tools such as Moodles, wikis, forums, blogs, Nings, and RSS feeds can provide access to opportunities to consume, create, and share information and ideas (see "Defining the Lingo").

Using these Web 2.0 tools, any member of the learning organization can post information and resources to which everyone has access. The routing slip has now turned into inclusive, generalized sharing of information and resources that enables teachers to reflect, ask questions, and make connections.

Using Twitter, for example, teachers can tailor the professional conversation as they "follow" particular education thinkers. The links users share on Twitter provide access to other resources and emergent thinking in the field, with levels of diversity and complexity that the routed resources could never touch.

Defining the Lingo

Web 2.0: This term describes a new generation of Web services and applications that offer the opportunity to collaborate, share, and create content through social networking tools, blogs, wikis, Nings, Moodles, RSS feeds, and so on. In contrast to noninteractive Web sites where users passively view information that others have created, a Web 2.0 site enables users to interact with other users or edit content.

Moodle: Originally an acronym for Modular Object-Oriented Dynamic Learning Environment, Moodle is an open-source course management system that educational institutions use to provide an organized interface for e-learning. Many people use the activity modules—such as forums, databases, and wikis—to build collaborative communities of learning around their subject matter. Anyone who uses Moodle is a *Moodler*.

Wiki: A wiki is a database of pages that visitors can edit using their own Web browser. A good example of a large wiki is Wikipedia, a free encyclopedia that anyone can edit.

Twitter: Twitter keeps users continually informed of timely bits of information in a variety of fields. Users send and receive short messages known as *tweets*, which are text-based posts of up to 140 characters. Users post their tweets via mobile texting, instant messaging, or the Web. *Following* someone on Twitter means getting their updates, or tweets. It someone gets your updates, they're following you. *Popularity* on Twitter usually refers to the number of followers a user has.

Blog: A blog is a contraction of the term *Web log*. It's a type of Web site, usually maintained by an individual, that features regular commentaries on a topic, includes links to resources, and often embeds such materials as graphics or videos. Teachers can easily create a blog at such sites as www.blog.com.

Ning: Ning is an online platform for people to create their own social networks. Users converse on a specific topic through forum posts and build resources by embedding videos and linking to articles and Web sites. For example, administrators in a book study group might use a Ning, in conjunction with face-to-face discussion, to enrich their learning experience.

Jing: Jing is free software that adds visuals to online conversations. Users can create a narrated video or tutorial, snap a picture of something on their computer screen, or give verbal feedback on a project and send this material over the Web or in an e-mail or instant message. Students might, for example, record themselves working on a math problem at home and then e-mail the file containing this video to their teacher or upload the video to their own Web page.

RSS Feeds: RSS—or Really Simple Syndication—is a family of Web feed formats that enable subscribers to get updates on frequently updated materials, such as blog entries and news headlines. Users receive the latest content from selected sites without having to visit them one at a time. Teachers can set up RSS feeds to easily access the latest thinking and news in the education world from selected thinkers and sources.

Forums provide the opportunity to post questions or share information, resulting in long-term, sustained conversations around teaching and learning. What is uniquely powerful about forums is the ongoing nature of the conversations. As teachers access resources and tackle problems in individual classrooms, they can enter the conversations and share information and ideas. Forum conversations provide a chronicle of professional thinking and become a valuable professional resource.

Structure 2: Look inward for insight.

A principal attends a national conference and wants to share his learning with the faculty. His school has established a Moodle containing an RSS feed of the school's Twitter account. The principal uses the Twitter account to live tweet as he attends the conference sessions so that his faculty can learn right along with him, even though they are hundreds of miles away.

On the basis of one of the principal's tweets focusing on differentiated instruction, the library media specialist posts a new journal article on the topic and establishes a wiki on the Moodle for teachers to share strategies around the ideas in the article. The principal's initial conference tweets have resulted in an ever-growing treasure trove of shared instructional strategies based on the latest thinking in the field, along with authentic examples of practice from teachers' classrooms.

Instead of relying solely on the expertise of others, teachers using Web 2.0 tools can synthesize what they've learned and distribute this expertise across the organization. Using Moodle, teachers can share their conference notes and ideas from professional learning opportunities with the entire learning organization.

Structure 3: Protect learning time.

The music teacher logs onto the Moodle to read the principal's weekly newsletter, which is posted to an updates forum. Instead of using faculty meeting or planning time, the principal has embedded a Jing—a video tutorial—in the newsletter that visually illustrates how to use the new tracking and payroll system. The Jing enables teachers to learn about the new system as well as ask questions through the forum. The principal has also posted a link in the newsletter to a great article on building cultural norms.

In the calendar part of the newsletter, the principal references an upcoming school concert. The music teacher seizes this opportunity to post an invitation to faculty members and provide some important details. Being able to post to the forum in response to the information eliminates the need for lots of e-mails about the concert—e-mails that clog mailboxes or that teachers may accidentally delete. The newsletters are archived so that teachers can easily access the resources, responses, information, and links provided each week.

One of the challenges for schools committed to ongoing professional learning is retaining the value of the conversations and learning that occur during such opportunities as faculty meetings. Schools can now do this using Web 2.0 tools.

Shared e-mail folders, forums, or Moodles enable communications that focus not only on upcoming events but also on data and other information that the school would otherwise share through binders and countless paper copies. Staff members can update information and share ideas around the resources in real time.

Using technology to take care of the administrivia that can creep into monthly faculty meetings can protect time for professional learning. Through forums, faculty members can converse and share resources before and after the meeting.

Learning 2.0 in Action

At the beginning of the 2009–10 school year, Northwood Elementary School established a Moodle as a protected place for professional learning and conversation. Located in a suburb of Buffalo, New York, Northwood is a K–6 school in the West Seneca Central School District; the school has 50 teachers and serves approximately 600 students. As the school principal, I work with the library media specialist to maintain the Moodle. The Moodle is open to all faculty members and houses a variety of learning opportunities.

Feedback on Lesson Plans

Teachers submit their weekly lesson plans electronically and receive my feedback in their own lesson plan drop box. Although the Moodle is public and collaborative, the lesson plans are visible only to the teacher and me. The feedback component of the drop box is set up as a wiki to promote ongoing,

private, and individualized conversation between teacher and principal.

Twitter
Teachers catch up on the latest professional reading and thinking using the Twitter account linked to the Moodle. When faculty members attend conferences, they use the Twitter account to update their colleagues in real time on the learning taking place. The thinkers and associations that faculty members follow on Twitter—such as ASCD, *Education Week*, Heidi Hayes Jacobs, and authors Daniel Pink and Stephen Covey, among others—align directly with Northwood's curricular and instructional norms and expectations. Teachers are encouraged to frequently check in to the school's Twitter account to update themselves on relevant professional discussions and reading.

Web 2.0 technologies can help schools create the structures necessary for sustained, complex, and meaningful professional learning.

Newsletter
Teachers stay updated on what is happening around the school by reading the weekly newsletter housed on the Moodle. Publishing the newsletter on the Moodle enables me to add resources, links, and information to which teachers have ongoing access. It also enables staff members to comment on and converse with one another about the information presented.

Forums
Forums are set up for discussion around a variety of topics: reading workshop, writing workshop, differentiated instruction, great reads, meeting the needs of learners with special needs, and Moodle help. On one forum, teachers recently shared observations about their students' progress in reading workshop as they implemented the model across the building. Another forum emphasized reading workshop structures, strategies, and texts.

Wikis
Each month, teachers participate in professional learning in faculty meetings that are conducted as workshops. At the first meeting of the year, groups of teachers, working by grade level or in a specific area, develop essential questions for each meeting date. The overarching essential question posed at the first meeting was simply, What do you need to learn? At the November meeting, the K–2 group discussed the question, How do retelling and other comprehension activities fit into the reading workshop? For the January meeting, the physical education department explored how to build more differentiated learning into its classes.

Wikis for each group are set up on the Moodle so that staff members can build meeting agendas collaboratively and post relevant resources both before and after the meeting. During the meeting, one of the team members captures the work that occurs around the essential questions—the conversation that ensues, the questions that team members pose, and various resources to consider—and records it in the wiki as the meeting progresses. After the meeting is over, a complete record of the learning is available on the wiki. All faculty members can continue to share, add to, and comment on the work undertaken.

Resources
Teachers can contribute to the school's list of audio/video resources as well as to the Northwood glossary on the Moodle. Both components enable teachers to share resources and continue the challenging work of creating a common vocabulary across the school. When the U.S. secretary of education was interviewed on TV, the video clip was embedded in the Moodle for all faculty members to watch. The speech teachers have recently expanded the school glossary, adding definitions related to speech therapy that classroom teachers can use in their own practice.

Blogs
Teachers use individual blogs on the Moodle to reflect on the influence this medium has had on their professional practice. They often comment on the flexible nature of the Moodle, which enables them to collaborate and reflect on issues when they are ready to engage around a topic, and on the open and interactive exchanges around teaching and learning. In addition, this practice has opened up discussions of how to use blogs in the classroom with students.

Emerging Issues
Schools can add blogs, forums, and wikis in response to emerging issues. For example, when our school engaged in a discussion related to emerging transiency issues within our student population, we created a spreadsheet and graph that compared the reading levels of new students with those of existing students and with district expectations. We posted this data in a forum with

some guiding questions, providing teachers with the opportunity to respond, converse, and create an action plan.

When the school needs to share a new procedure, staff members can create Jings or forums for teachers to use. For example, we created a Jing that showed teachers how to use the Moodle, and we posted it in the glossary on the Moodle as a reference for teachers as they interacted with this tool for the first time.

Staff members can also use a wiki to assess interest and build a collaborative agenda when planning an upcoming professional learning opportunity.

A Powerful Blend

Together, the faculty and administration at Northwood have built a professional learning resource that supports their work in the classroom, promotes communication, and creates connections as part of an overall blended professional learning environment. In fact, the work on the Moodle has strengthened face-to-face interactions. Teachers who may not have had the opportunity to interact daily now can access the thinking of their colleagues.

What is uniquely powerful about forums is the ongoing nature of the conversations.

For example, it has become increasingly common for faculty members to make face-to-face connections on the basis of a forum post.

With Moodle and other Web 2.0 tools, teachers no longer need to go to a specific place for professional development or wait to hear someone from the outside tell them what they need to do. Rather, ongoing professional learning is now part of the culture of the school. As they collaboratively construct understanding, teachers and administrators alike define who they are, how they communicate, and how they can best serve their students. EL

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Victorian Institute of Teaching
THE DIGEST

2009/1

victorian institute of teaching

Value learning. Value teaching

IN THIS EDITION

The Victorian Institute of Teaching has commissioned the Australian Council for Educational Research to prepare this series of electronic research digests.

This digest has been prepared by Marion Meiers, Senior Research Fellow and Pat Knight, Senior Librarian, Cunningham Library, ACER. Expert advice has been contributed by Gerry White, Principal Research Fellow, Research and Learning, ACER.

This Digest is available in a PDF version on the Victorian Institute of Teaching website at: http://www.vit.vic.edu.au/

The Digests

This Digest is one of a series of periodic digests produced by the Australian Council for Educational Research (ACER) for the Victorian Institute of Teaching. The digests will be published on the Institute website under 'Publications'.

Each digest focuses on a single topical issue, and provides a review of major messages from research on the issue. A key feature of the digests is an emphasis on what the research means for teachers and teaching. Over the course of several editions, a wide range of issues will be covered, so that teachers from different areas of schooling will find topics of relevance to their needs and interests.

Previous Issues

2007/1 *Writing to learn*
2008/1 *Managing student behaviour in the classroom*
2008/2 *Using Data to Improve Learning*

The use of ICT in schools in the digital age

This edition of The Digest is focused on research that has investigated aspects of digital learning. The body of research sometimes described as 'e-learning research' (Andrews & Haythornthwaite, 2007) encompasses many aspects of ICT in education, at many levels and in many contexts. For the purposes of this digest, the key question is *What does research tell us about digital learning in schools?*

The first section of the digest is focused on the diverse uses of ICT in schools, and evidence about the ICT literacy of Australian students. This is followed by an overview of evidence about the impact of ICT on student learning. Two short sections present some evidence about how technology can help to improve science learning, and some findings from research on interactive whiteboards in teaching and learning. The final section offers some practical accounts of using ICT to support learning.

The digest draws on searches of a number of databases and bibliographic resources, including the Australian Education Index, Education Resources Information Center (ERIC), Education Research Complete, British Education Index and Scopus.

A selection of relevant websites is listed, and a full reference list is provided. Links to those references for which full-text online access is freely available are also included.

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Successful uses of ICT in schools

Successful learners have the essential skills in literacy and numeracy and are creative and productive users of technology, especially ICT, as a foundation for success in all learning areas

The preamble to the 2008 Melbourne Declaration on Educational Goals for Young Australians (MCEETYA, 2008) acknowledges a number of changes and new demands on Australian education.

… rapid and continuing advances in information and communication technologies (ICT) are changing the ways people share, use, develop and process information and technology. In this digital age, young people need to be highly skilled in the use of ICT. While schools already employ these technologies in learning, there is a need to increase their effectiveness significantly over the next decade.

This statement recognises that ICT is used extensively in schools, and also highlights accelerating changes in ICTs. The second of the two goals in the declaration is that all young Australians become successful learners, confident and creative individuals, and active and informed citizens (Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA), 2008). Successful learners have the essential skills in literacy and numeracy and are creative and productive users of technology, especially ICT, as a foundation for success in all learning areas. (MCEETYA, 2008) The explicit reference to ICT as an essential skill for successful learning raises many questions about what research has already identified in relation to how ICTs improve learning.

This perspective on Australian education reflects the diverse use of modern ICT in many countries. A recent OECD study reports that, in all OECD countries:

In schools it is now common to see ICT being used by students to write essays, find information for projects and assignments, compose music, share ideas with students in other schools, conduct simulations, build databases, create works of art and do detailed architectural drawings. (OECD, 2005b)

Within Australia and New Zealand, a survey-based evaluation of online curriculum materials produced by The Le@rning Federation has provided insights into the perceptions of teachers, school leaders and sector personnel about the uses and benefits of information and communication technologies in classrooms and the factors that encourage its classroom use. This evaluation has found a generally low adoption of ICT, due to various factors, including a lack of alignment between curriculum, pedagogy, assessment of students' performance, and high stakes testing. (Freebody, P., Reimann, P. & Tiu, A., 2008a)

The findings of the evaluation survey of The Le@rning Federation's (TLF) online curriculum materials (Freebody, P., Reimann, P. & Tiu, A., 2008b) identified a number of factors concerning the use of online curriculum material in the current school context, including, for example:

- *Teachers vary considerably in their reported rates of familiarity and professional development experiences with TLF materials, and report low levels of professional development, although higher than reported in earlier surveys.*
- *The curriculum areas with the highest use of TLF materials are mathematics, English/literacy and science. Studies of Society and the Environment and cross-curricular integrated studies now have higher reported rates of use than those reported in earlier studies.*
- *Teachers who use TLF materials continue to report very favourably on their value for students' learning and engagement.*
- *In estimating the importance of a range of factors that enable teachers to adopt new digital/online technologies in their teaching, teachers place less emphasis on those related to ease of use and support in ICT than do school leaders and sector personnel. Teachers also view pressure from outside sources for them to use ICT to be of less importance than do sector personnel. Policies and syllabuses for ICT are seen as a stronger influence by teachers than by principals and sector personnel.*

The new demands made by ICT have prompted discussion: *… it's the relatively new uses of the internet and worldwide web that are stimulating new demands and expectations in education.* (White, 2008a) There is also clear recognition of the need for research about questions of the impact of ICT on learning and education:

The internet and www have caused considerable changes to the ways we access and use information as well as communicate that are having a continuing impact on education. The sheer richness of media and the diversity of processes that can be applied to those media mean that we need research into their effects on learning. (White, 2008b)

Research addressing this topic takes many forms, including large-scale investigations of the range of ICT literacy amongst students, reports from schools and classrooms about students' responses to new teaching practices integrating a range of ICTs and students' responses to these approaches, as well as meta-analyses of rigorous research seeking to determine the impact of ICTs on learning. In different ways, all of this research explores key questions about the impact of ICT on learning.

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What do we know about the ICT literacy of Australian school students?

Communication with peers and using the internet to look up information are frequent applications but there is much less frequent use of applications that involve creating, analysing or transforming information

National assessments of the ICT literacy of Australian school students in Years 6 and 10 were conducted on behalf of the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) within the National Assessment Program in 2005 and 2008. These assessments were based on a definition of ICT literacy that drew on the Framework for ICT Literacy developed by the International ICT Literacy Panel:

the ability of individuals to use ICT appropriately to access, manage, integrate and evaluate information, develop new understandings, and communicate with others in order to participate effectively in society. (MCEETYA, 2007)

The assessment framework envisaged ICT literacy as comprising six key processes:

1. *Accessing information – identifying the information needed and knowing how to find and retrieve information;*
2. *Managing information – organising and storing information for retrieval and reuse;*
3. *Evaluating – reflecting on the processes used to design and construct ICT solutions and about making judgements regarding the integrity, relevance and usefulness of information;*
4. *Developing new understandings – creating information and knowledge by synthesising, adapting, applying, designing, inventing or authoring;*
5. *Communicating with others – exchanging information by sharing knowledge and creating information products to suit the audience, the context and the medium; and*
6. *Using ICT appropriately – making critical, reflective and strategic ICT decisions and about using ICT responsibly by considering social, legal and ethical issues.* (MCEETYA, 2007)

In the 2005 national assessment, an ICT Literacy Scale was developed, and proficient standards were established for each level. At Year 6, 49% of students achieved the proficient standard, and at Year 10, 61% achieved the proficient standard. (MCEETYA, 2007)

The results of the survey provide an interesting picture, suggesting that students use ICT in relatively limited ways.

Communication with peers and using the internet to look up information are frequent applications but there is much less frequent use of applications that involve creating, analysing or transforming information. There are substantial differences between Year 6 and Year 10 suggesting that considerable growth in ICT proficiency takes place over these four years. Within each year level there are differences associated with socioeconomic background, Indigenous status and remote geographic locations. (MCEETYA, 2007)

In 2005 49% of Australian students in Year 6 were able to

generate simple search questions and select the best information source to meet a specific purpose, retrieve information from given electronic sources to answer specific, concrete questions, assemble information in a provided simple linear order to create information products, use conventionally recognised software commands to edit and reformat information products. (MCEETYA, 2007)

In 2005 61% of Australian students in Year 10 were able to

generate well-targeted searches for electronic information sources and select relevant information from within sources to meet a specific purpose, create information products with simple linear structures and use software commands to edit and reformat information products in ways that demonstrate some consideration of audience and communicative purpose. (MCEETYA, 2007)

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Is ICT availability and use associated with student performance?

of functions and not just to play games;

- one-half of the students reported frequent use of the Internet as a research tool and frequent use of word processing software;
- the vast majority of students were confident in performing basic ICT tasks such as opening, deleting and saving files. (OECD, 2005a)

The results from PISA 2003 showed that some features of ICT availability and use were strongly associated with student performance, but this was not the case for all features.

… in an age in which computers feature strongly in everyday life and in education, the minority of students who have little access to them, who use them little and who are not confident in using ICT are not performing well. This is partly because students with low home access are more likely to come from disadvantaged backgrounds, but the observed gap cannot nearly be explained by socio-economic status. Thus, the disadvantages faced by students whose parents have low educational or occupational status are likely to be exacerbated where they also do not have access to computers. The PISA evidence confirms previous studies showing the particularly strong association of performance with home access and usage. (OECD, 2005a)

A 2004 OECD education policy analysis addressed a number of significant current policy initiatives, including the extent to which ICT was being used to improve teaching and learning in schools. One finding from this analysis was that *in all OECD countries, low-achieving 15-year-olds seemed to be just as interested in using computers as other students, with no statistically significant differences emerging on a scale of interest in ICT between the scores of the lowest literacy achievers and other students.* (OECD, 2005b)

Another finding of importance to schools was that in nearly all OECD countries, low achievers' access to ICT was greater and more equitable in the school than in the home. There was an extremely strong and significant trend for low-achievers to report less access in the home than that reported by high achievers. (OECD, 2005b)

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What is the evidence of impact of ICT on learning?

More substantial gains in pupil attainment are achievable where the use of ICT is planned, structured and integrated effectively

This question about evidence of the impact of ICT on learning has been the focus of a number of studies in recent years. Reviews of research, and meta-analyses synthesising research in various learning areas have yielded some evidence about positive impact on students' learning.

A professional user review of UK research was undertaken for the British Educational Research Association (BERA) in 2003. A range of sources was included in the review, which found that ICT can help students to learn and teachers to teach more effectively, although the review noted that there is not a simple message in such evidence that ICT will make a difference simply by being used. (Higgins, 2003)

Some key messages from the research

More substantial gains in pupil attainment are achievable where the use of ICT is planned, structured and integrated effectively.

Computers should be used to enhance aspects of teaching through the presentation of information in different ways and in different forms.

Effective use of ICT can support the development of understanding across the curriculum. (Higgins, 2003)

In 2003 Higgins suggested the need for flexibility in curriculum and assessment to accommodate technological change, although by 2008 it seemed clear that ICTs have brought about changes in the curriculum as the developing technologies provide new avenues for accessing knowledge.

A series of systematic reviews of research studies on the impact and effectiveness of ICTs in teaching and learning has been conducted through the EPPI-Centre at the Institute of Education, University of London. Systematic reviews seek out as much research as possible on specific research questions, and use a rigorous methodology to screen the studies to determine what can reliably be said about their findings. The research findings are then synthesised into a form accessible to policy makers and practitioners.

Findings from systematic reviews of ICTs on aspects of literacy learning in English

The EPPI-Centre has undertaken several systematic reviews of the effectiveness of ICTs in different aspects of literacy learning in English. The first of these (Andrews, et al, 2002) identified the interest in the impact of information and communication technologies (especially computers, networked computers, mobile phones) on young people's learning, and investigated the impact of networked technologies – the internet and email – on literacy learning. The results of the review were suggestive rather than conclusive, but in general, *the studies assumed that networked ICT had a positive impact, and explored how that impact was made. Increased motivation for literacy, empowerment and ownership were considered to be important factors. Most studies used a pre-digital conception of literacy.* (Andrews et al., 2002)

The report of this review drew out the implications of the findings for teaching, and suggested that, *In practice, more attention needs to be given to how ICT is used both within the classroom and at home to see it as one tool of many which can support literacy learning.* (Andrews, Burn, Leach, Locke, Low, & Torgerson, 2002) The review recommended that further in-depth work be done on areas such as email, conferencing and the internet; writing and composing multimedia; on-screen reading and hybridity of the verbal and visual in multimedia, and noted that a range of research methods and types of study were needed, including teachers' action research projects.

More recently, a systematic review addressed the question, *what is the evidence for the effectiveness of different ICTs in the teaching and learning of English (written composition), 5–16?* (Andrews et al., 2006)

Interestingly, the findings of the review were reported as follows: *… it was not possible to arrive at a clear answer to our in-depth research question. Rather, we wish to report that the field is in a pre-paradigmatic state where definitions of English, literacy and ICT are still relatively unclear and where the causal and/or symbiotic relationship between them has yet to be fully theorised. The most authoritative study in terms of the present review … showed that ICT made little difference to an experimental group of 'learning disabled' students in terms of writing quality, but that, for lower-order writing skills, improvements happened at a faster rate for such students as well as there being an increase in self-esteem for these students.*

The report provided some advice to teachers, suggesting that ICT *is best seen as another tool in the repertoire available to learners and teachers for expression and communication. Custom-made word processing and other software programs should be considered by teachers, as some of these prove to be more attuned to the writing process than others. Teachers also need to be aware that there are times when the use of ICT is appropriate for a particular writing task (or part of that task), and other times when different media are more appropriate.* (Andrews et al., 2006)

Findings from systematic reviews of ICTs in science, mathematics, and writing

A systematic review of research in science learning posed the question: *what is the effect of ICT teaching activities in science lessons on students' understanding of science ideas?* (Hogarth, Bennett, Lubben, Campbell & Robinson, 2006) The in-depth review of research from 2000-2005 identified evaluation studies from 10 countries on the use of simulation to teach the understanding of science ideas. These studies included a control and pre- and post-testing of achievement of students aged 11-16.

The findings of the systematic review suggested that simulation has potential value in classrooms:

- Simulations fell into two main categories – simulation of specific experiments and simulations of a wider scientific situations ... . Both types of simulation can improve students' understanding compared to non-ICT/traditional teaching and learning activities.
- Students' use of ICT simulations helped them to improve their understanding of science ideas more effectively compared to the use on non-ICT teaching activities.
- Students' use of ICT simulations was more effective than using non-ICT teaching activities for improving basic science ideas including science understanding and the scientific approach.
- However the improvement in higher levels of understanding (for example, the transfer of scientific knowledge from one situation to another and experimental design) can equally well be achieved when students use traditional (non-ICT) teaching approaches.
- The gains in students' learning when using ICT simulations were further enhanced when teachers actively scaffolded or guided students through the ICT simulations. (Hogarth et al., 2006)

A systematic review of ICTs in mathematics found evidence to answer the research question: *How have different information and communication technologies (ICTs) contributed to the development of understanding of algebra for pupils up to the age of 16?* Major findings were that:

- pupils achieve general gains of understanding when using one type of ICT
- students successfully use visualisation with graphing software to fit graphs to datasets, to solve equations and to transform functions.
- pupils working in a computer environment reach higher levels of thinking and are able to explain their thinking better than pupils working in a paper and pencil medium.
- lower attaining students prefer to work arithmetically with tables of values and only later move to integrate the tables of values with computer-generated graphs.
- pupils have difficulty moving between symbolic, tabular and graphical forms when solving equations.
- students do not always know how to use the technology, interpret ambiguities in the output or exercise critical judgment when using some of the advanced calculators. (Goulding & Kyriacou, 2008)

The report of this systematic review drew on the findings to provide practical advice for teachers. This example relates to the management of individual, small group work and whole class work.

Opportunities for students to experiment with technology

Teachers need to negotiate a balance between the individual constructions which may develop when pupils work alone or in small groups with the technology, and common knowledge developed within the whole class. Although this is a consideration in any teaching situation, technology may be particularly fruitful in encouraging individual experimentation. This is desirable but needs to be tempered by teachers encouraging sharing within the whole class. The last point is also relevant when considering the use of electronic whiteboards and computers connected to data projectors. If this is completely within the control of the teacher, then pupils may not have the opportunity to experiment with the technology themselves. (Goulding & Kyriacou, 2008)

Other large-scale reviews of studies of ICT impact on schools provide further perspectives. A review from European Schoolnet of the impact on schools in Europe identified the following findings from a review of 17 recent impact studies and surveys at the national European and international levels. The authors summarised the findings of ICT impact in eight statements:

1 ICT impacts positively on educational performance in primary schools, particular in English and less so on science and not in mathematics.
2. Use of ICT improves attainment levels of school children in English- as a home language- (above all), in Science and in Design and technology between ages 7 and 16, particularly in primary schools.
3. In OECD countries there is a positive association between the length of time of ICT use and students' performance in PISA mathematics tests.
4. Schools with higher levels of e-maturity demonstrate a more rapid increase in performance scores than those with lower levels.
5. Schools with good ICT resources achieve better results than those that are poorly equipped.
6. ICT investment impacts on educational standards most when there is fertile ground in schools for making efficient use of it.
7 Broadband access in classrooms results in significant improvements in pupils' performance in national tests taken at age 16.
8. Introducing interactive whiteboards results in pupils' performance in national tests in English (particularly for low-achieving pupils and for writing), mathematics and science, improving more than that of pupils in schools without interactive whiteboards. (Balanskat, Blamire, & Kefala, 2006)

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ICTs in science classrooms

The crucial role of the teacher in orchestrating the learning environment at cognitive, pedagogical and technological levels

Another meta-review (Todorova, Fischer, Ludvigsen & de Jong, n.d.) addressed the question: *"how can technology help to improve science education?"* This review distinguished two broad functions of technology with special relevance for science education, serving as a means for

a. *experiencing natural systems and phenomena, and*
b. *facilitating science learning processes.*

The report of this review notes the crucial role of the teacher in orchestrating the learning environment at cognitive, pedagogical and technological levels.

Experiencing natural systems and phenomena	Facilitating science learning processes
Simulating and modelling phenomena … enables learners to investigate and understand more complex models than in a school laboratory	*Accessing a variety of resources* … access to scientific texts and lectures, news, hypertext and hypermedia materials or scientific data, is a function of technology with high relevance for science learning.
Visualising systems and phenomena … two- and three-dimensional graphs, video, animations and virtual environments can make explicit underlying models and concepts, represent complex data sets, and illustrate ideas.	*Scaffolding* … technology can provide scaffolding through prompts, hints, questions, concept maps, tutorials, intelligent tutoring applications.
Data capture and display … data-collecting and logging appliances, microcomputer-based laboratories, databases, spreadsheets and graphing tools are used to capture and display real data.	*Communicating and collaborating* … emails, weblogs, discussion boards, chat-rooms and collaborative electronic environments facilitate students' working together on tasks, sharing their knowledge and expertise, and producing joint outcomes. (Todorova et al., n.d.)

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Interactive whiteboards

Positive impacts depend on the ways in which interactive whiteboards are used

Interactive whiteboards are a relatively recent technological innovation in schools, and while there is limited research literature in refereed academic journals about their impact on students' learning, there are many projects that have been undertaken at local and school level that have been reported in the professional literature.

A 2007 account of innovative uses of interactive whiteboards in Western Australian country schools presents evidence from a number of classrooms about ways in which the introduction of interactive whiteboards are reported to have improved teaching. One teacher noted that:

'As a teacher, the use of the interactive whiteboard is very rewarding as you can actually see your students taking an active interest in their education and developing in ways, that in my opinion, are not possible under conventional teaching practices.' (Bayne, 2007)

The ICT specialist at another of the schools in Bayne's account described some of the changes in teaching that he had observed.

'For their own part, teachers are reporting more streamlined and organised planning, preparation and execution of their lessons due to their use of the interactive whiteboard notebook software and direct access to all the resources on the school network.' (Bayne, 2007)

A small scale, school-based action learning study conducted in a remote Western Australian school explored the impact of the introduction of interactive whiteboards on the teaching practices of a group of teachers. The focus of the action research was on ways that teachers thought about their teaching and planned for the achievement of learning outcomes with the introduction of interactive whiteboards. Findings from this study demonstrated that the use of interactive whiteboards encouraged reflective practice and lead to increased awareness of the benefits of interactive teaching and learning. It is of interest that the study also indicated that changing classroom practices takes time, and teachers progressed though stages of development in the ways they utilised new technology. (Sparrow, Frid & Smith, 2008)

An analysis of the emerging body of literature on the effective use of interactive whiteboards in teaching and learning was conducted by the British Educational Communications and Technology Agency (Becta). The analysis indicated that interactive whiteboards can have positive effects on teaching and learning in general, and provide benefits for teachers and for students. The report notes that positive impacts depend on the ways in which interactive whiteboards are used, and that, although the literature on this technology is emergent, and further research, both qualitative and quantitative, will be needed, there was evidence of good practice and positive outcomes across the curriculum. (Becta, 2003)

One of the studies included in the Becta analysis identified three levels of whiteboard use:

- *to increase efficiency, enabling teachers to draw upon a variety of ICT-based resources without disruption or loss of pace*
- *to extend learning, using more engaging materials to explain concepts*
- *to transform learning, creating new learning styles stimulated by interaction with the whiteboard.* (Glover & Miller, 2001)

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Exploring impact on learning

This new form of instruction gave me chance to interact with all of my students

Two recent studies provide insights into the nature of learning with technology.

Responding to researchers' recognition that in *an age of information, it is important to identify the information-seeking strategies that we use while reading on the Internet to better inform both research and practice*, Coiro and Dobler (2007) undertook a qualitative study to explore the nature of reading comprehension processes while reading on the Internet. Two research questions guided the study:

1. *What characterizes the reading process as skilled readers search for and locate information on the Internet?*
2. *What informs the choices that skilled readers make as they search for and locate information on the Internet?* (Coiro & Dobler, 2007)

The sample comprised 11 skilled sixth grade readers from three middle schools in the central and northeastern United States. These students met individually with a researcher, and completed two separate tasks that involved reading on the Internet, and in a follow-up interview answered specific questions about their strategy use. Four phases of qualitative analysis were used to investigate the data.

Coiro and Dobler found that *the skilled readers in their study shared insights that suggested that successful Internet reading experiences appeared to simultaneously require both similar and more complex applications of (1) prior knowledge sources, (2) inferential reasoning strategies, and (3) self-regulated reading processes.* (Coiro & Dobler, 2007)

The students used both familiar knowledge sources and new knowledge sources to comprehend the Internet text. The researchers observed skilled readers actively applying a range of inferential reading strategies with students' responses to interview questions identifying the strategy. For example, one student said:

'I'm going to choose "Weather for hurricanes and typhoons" [clicked on link], and now I'm going to read the lists of sites and information about them to see if they're good, and this looks like a good site, 'cuz it says [after the hyperlink] "See how hurricanes are formed" and it might have information on hurricanes losing their power.' (Coiro & Dobler, 2007)

Data from the study suggested that *higher achieving sixth-grade readers with Internet reading experience are aware of and demonstrate strategic online reading processes to a higher degree than their less skilled peers with Internet reading experience.* (Coiro & Dobler, 2007)

Another example of insight into how students use ICT to learn is found in a teachers' description of an electronic discussion board-related assignment completed by her grade ten history students.

To begin, she immersed her classes in an electronic discussion board system. The first online discussion was conducted in response to this initial question:

Based on your reading of Chapter 22 and your class notes, do you believe that the causes of the French Revolution were primarily economic or primarily political? Explain your response using examples to support your argument. You must respond first by giving your point of view. Then, revisit the discussion three more times on three different days to contribute to your group's conversation. (Snyder, 2008)

In practical terms, Snyder found that 10 students was the optimal number per discussion group, and four postings was a manageable number in a 10-person discussion group. She found that two weeks enabled students to overcome any technological obstacles and provided an opportunity for the discussions to blossom. She monitored the discussion daily, and at the end of the two weeks gave specific feedback to each group, highlighting good insights and communication techniques. She concluded that:

Perhaps the most rewarding aspect of instituting this feature into my 10th grade class was that at the end of the year, I felt like I knew my students' abilities much better than I ever had. Reading their posts provided me with insight into how they were thinking and reasoning. It is yet another tool to assess students' learning. … This new form of instruction gave me chance to interact with all of my students and learn their abilities in much more helpful detail. (Snyder, 2008)

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comment

The body of research on the impact of technological innovations continues to expand as the take-up of ICT in schools increases. The possibilities of integrating technological communication and information resources into effective classroom practices are widely acknowledged, and there is a growing body of evidence indicating the positive impact of such practices. Evidence about the nature of students' levels of ICT literacy and about the diverse ways in which ICT is used in contemporary classrooms has many implications for future directions in education.

There is clear recognition of the need to expand the range and scope of research methodologies in the area, and the need for teachers to be

more involved in the design of ICT artefacts, and … to be more involved in research on how students use these artefacts. (Freebody, Reimann & Tiu, 2008a)

White (2008b) draws attention to the

… sheer richness of media that is available and the diversity of processes that can be applied to those media mean that we need research into their effects on learning. We also need to look at the capacity for education to explore these aspects of the use of ICT in education if we're to enable progress that is more than haphazard.

This digest has drawn on rigorous large scale studies to help in providing a map of the challenging territory of ICT in education, as well as on more focussed studies of classroom practices. The need to continue and broaden research into the impact of ICTs is emphasised in the following recommendation about the uses of ICT in schools:

Learning objects, and ICT more generally, need to be seen as both curricular and technical interventions into classrooms. In that regard their use poses challenges to teachers and students that are cognitive, attitudinal, technical and practical. Studying their adoption, adaptation and sustained use therefore means building up detailed knowledge from a variety of case sites, targeting practices and outcomes in close-up designed-based interventions in which everyday practices – initiations, modifications, challenges, responses and outcomes – are documented and disseminated. (Freebody, Reimann, Tiu, 2008a)

A number of key messages emerge from the body of research evidence about the uses of ICT in schools in the digital age:

- teachers' confidence about using ICT in the classroom is variable;
- ICT learning objects are used mostly in mathematics, English and science;
- the use of computers is common at home and at school;
- students use ICT in limited ways. Information access and searching are common, but creating, analysing and transforming information are less common.

ICT improves student engagement, supports learning in a variety of ways, and is both a tool and process for new ways of thinking and learning. For example, simulations are powerful learning tools. ICT can assist general gains in mathematics and has a positive impact in primary schools especially, in English. Student performance improves with time when using ICT, but low access to ICT and low confidence in using ICT corresponds to low performance. Innovative uses of ICT continue to evolve: for example, teachers can provide new learning opportunities for students by using interactive whiteboards, or electronic discussion board systems. Overall, the effective use of ICT in schools is planned, structured and integrated.

USEFUL WEBSITES

The EPPI-Centre in the Social Sciences Research Unit at the Institute of Education, University of London provides access to an extensive evidence library of reports of systematic reviews of research evidence. Many of these reports present findings of research and indicate practical implications for teaching.
http://eppi.ioe.ac.uk

The Le@rning Federation develops digital curriculum content for all Australian and New Zealand schools. The project is a collaborative initiative of all Australian and New Zealand governments. The 'Teacher ideas' section of the website provides access to teachers' accounts of successful practices.
http://www.thelearningfederation.edu.au/default.asp

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Learning: Peering Backward and Looking Forward in the Digital Era

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Introduction

Both in common parlance and within the academy, the word "learning" has broad and varied meanings. On the street, we apply the same term to a child who, as a result of bitter experience, will no longer tease an older, tougher peer, and to those who achieve the highest Latinate degrees after many years of study at the University. In the field of psychology, "learning" was the major topic in America for fifty years, before it was replaced and almost consigned to oblivion, courtesy of the "cognitive revolution" of the 1960s (Gardner 1985). Now, with study becoming a lifelong enterprise, and with the advent of a galaxy of new media, "learning" seems once again poised to become all things to all people, be they lay or scholarly.

In this article we bracket our task by using a restrictive definition of "learning." We assume that in any society, certain information, knowledge, skills, beliefs, and values need to be transmitted to the younger generation. By the same token, there will certainly be new information, knowledge, skills, beliefs, and values that will be important in the future, though elders may not be willing or able to anticipate the specifics of these new competences. (We use "competences" as an umbrella term to cover this complex of information, knowledge, skills, beliefs, and values.) Some of the competences occur almost automatically: Young children will not survive unless they avoid steep drops, but no explicit instruction is necessary (Gibson and Walk 1960). At the same time, children are strongly disposed to be treated fairly, and have at least some inclination themselves to treat peers fairly (Damon 1988). We will not be concerned with such "natural" or "ready" or "highly predisposed"

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learning. Some messages are conveyed so powerfully in a society that formal instruction is unnecessary. American youngsters do not need formal instruction in the operations of the marketplace (i.e., buying, selling, consuming, competing, etc.), the rules of baseball or popular music, or navigation by automobile; Chinese youth, a half century ago, took for granted a socialist economy, agitprop works of art, and navigation of bicycles. We will assume and not comment further on "universal learning within a culture" (Feldman 1980).

Having thus restricted our terrain, our focus here falls on those competencies that require some kind of formal instruction, tuition, or scaffolding on the part of the individuals, organizations, and/or media of the ambient society. Put differently, we direct our attention to those forms of learning that do not occur automatically, readily, naturally, or by dint of simply living in a certain place at a certain time. (In this way, we also eliminate from consideration most of what is considered learning in organisms other than primates and higher mammals; cf. Hauser 2000.)

We begin with a consideration of how learning took place in the distant past; then turn to learning as it evolved in recent centuries; then direct our focus to the challenges and opportunities of learning going forward in the digital era. Our sketch of "learning past" will be just that—a cook's tour, perhaps necessary, at least brief. As shown in table 1, we will be cognizant throughout of who the learners are, where they learn, how they learn, what are the principal curricula, and how competences are purveyed via the media of the time. The grid itself contains generalizations about the past and present, and speculation about the future, thus providing a broad portrait of changes over time. While we do not discuss each entry in the grid, we hope that it aids in thinking about learning in formal and informal settings.

In this article we argue that, after millennia of considering education (learning and teaching) chiefly in one way, we may well have reached a set of tipping points: Going forward, learning may be far more individualized, far more in the hands (and the minds) of the learner, and far more interactive than ever before. This constitutes a paradox: As the digital era progresses, learning may be at once more individual (contoured to a person's own style, proclivities, and interests) yet more social (involving networking, group work, the wisdom of crowds, etc.). How these seemingly contradictory directions are addressed impacts the future complexion of learning. Throughout this article we draw upon a variety of resources to inform our arguments, including scholarly research, general interest articles, blog posts, and research in progress by our team at Harvard Project Zero, including The Developing Minds and Digital Media Project and The GoodPlay Project.

Peering Backward

Traditional Learning

The invention of writing is crucial in any account of the history of learning. Until the invention of writing, we have no written and scant graphic evidence of how learning took place. Building on findings with primates, preliterate cultures (which are rapidly disappearing from the planet), and extrapolations from scattered tools and graphic artifacts, we can assume that most traditional learning took place by observation—presumably with oral linguistic accompaniment, though it is not clear how crucial a role was played by lexicalization (putting ideas or procedures into words) per se. Girls watched older women plant, gather, sew, swaddle, raise younger children, and play roles in decisions vis-à-vis the household; as soon as possible, the growing girls began to participate in these activities. Boys watched older men hunt, fish, engage in combat, and play roles in decisions vis-à-vis marriage and wider communal and extra-communal relations. More often in the case of boys, the transition to adulthood was marked by initiation rites, which often included introduction to hermetic knowledge, such as that involved in successful hunting or war making. With rare exceptions, we infer that in these learning environments, children were to be seen and not heard.

As skills within traditional communities became more specialized, there is likely to have been more explicit tutelage, perhaps for offspring of elite families, perhaps also for those young persons, of whatever social origins, who displayed special aptitude in one or several spheres. In considering possible occupational specializations, one might include knowledge of astronomy, ability to sail large distances, skills in healing, and the ability to perform music, dance, or graphic depiction at a high level of competence. It is doubtful that, for example, all young persons in a Paleolithic era were inculcated in the skills needed for

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Table 1 Learning Over Time

Periods	WHO learners	WHERE	purveyors of learning	HOW dominant pedagogies	dominant instructional media	dominant cultural media	WHAT major content/curricula	implicit content/curricula
pre-literate era	all children	family, community, "bush schools"	family, community	participation, observation	indeterminate	oral	meaning-making in context	survival, documentation, ceremonial
pre-modern era (1439 - 18th c)	mercantile and elite males	apprenticeships and formal schools	experienced and knowledgeable adults	participation, observation, instruction	images, text	images, text	basic literacy, technical or specialized domains	commerce, obedience, religious education
modern era (19th c to 1950s)	w/rise of public education, most children ages 5–18	formal (classroom)	primarily female educators, teachers as experts, students as passive recipients	uniform schooling, received wisdom, one-size-fits-all learner/learning	print	rise of mass media - print, broadcast (radio/tv/film)	humanities and language/literacy, socialization, routine	preparation for work, discipline, citizenship
late/high modernity (1960 to 2000)	all children	formal (classroom)	teachers as experts, students as passive recipients (emergent: teachers as facilitators, students more active)	uniform schooling, received wisdom, one-size-fits-all learner/learning (emergent: early constructivism, early individualization/multiple intelligences, social learning)	print, some broadcast	mass media - print, broadcast (radio/tv/film) emergent: digital media	emphasis on science vs. humanities/literacy	consumerism
personal computing—digital age (1980–present)	all children	formal (classroom) (emergent - informal; classrooms persist but learning increasingly happening anywhere)	teachers as experts, students as passive recipients (emergent: teachers as facilitators, students as co-architects, self-directed learning, peer learning)	uniform schooling, received wisdom, one-size-fits-all learner/learning (emergent: constructivism, contextualized learning, social learning/distributed cognition)	print, broadcast (emergent: digital media)	mass media digital (internet/web 2.0) emergent: portable digital media	emphasis on science (emergent: interdisciplinarity)	diversity, consumerism
future—insufficiently supported	all (lifelong)	formal for all, informal for privileged	self learning, peer learning, teachers less relevant, students as unsupported, limited learning due to distractions	split between direct instruction and autonomous work, direct instruction, traditional pedagogies remain, autonomous work, constructivism, contextualized learning, social learning/distributed cognition	print, broadcast digital (internet/web 2.0), portable digital media, augmented reality	digital (internet/web 2.0), portable digital media	3Rs, disciplines, interdisciplinarity metacognition, new media literacies, globalization, ethics	global participation as a thoughtful producer, consumer, and citizen for some
future—well-supported	all (lifelong)	formal and informal for all	self-directed learning w/ supports peer learning w/ supports, teachers as facilitators, students as co-architects	balance of autonomous and scaffolded learning, supported constructivism, contextualized learning, social learning/distributed cognition	print, broadcast digital (internet/web 2.0), portable digital media, augmented reality	digital (internet/web 2.0), portable digital media	3Rs, disciplines, interdisciplinarity metacognition, new media literacies, globalization, ethics	global participation as a thoughtful producer, consumer, and citizen

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cave drawings of animals or for the use of herbs and prayers in healing. It is possible that certain individuals were deemed to be especially skilled teachers, over and above their own skills in the task at hand. Recent studies confirm that children as young as three years old understand the role of teacher and are able to take into account the knowledge of their "pupils" (Strauss 1997; Tomasello 1999); it stands to reason that, over and above the modeling done routinely by parents and other adults, certain individuals honed their skills in teaching the young.

Our best evidence suggests that the learning took place in so-called "bush schools"—convenient ad hoc loci where learners benefited from the examples, lore, and instructions of designated experts. It is likely that these settings were at or close to the places in which the knowledge was actually deployed—decontextualized learning had yet to emerge.

The First Schools

While the Sumerians are generally credited with the invention of writing as we know it, the efflorescence of various graphic means of encoding knowledge occurred in several regions of the world starting about 5,000 years ago. Beginning with pictographs, then moving to rebuses, syllabaries and, finally, strictly alphabetic systems, the scribes of various civilizations succeeded in recording important events from the past, current events and concerns, prayers, and legal procedures and regulations in written form. At roughly the same time, the encoding of numerical and mercantile information also came into its own, as scribes recorded exchanges, possessions, and calendrical information in terms of numerical totals, estimates, and operations.

Probably for the first time in human (pre) history, the need for a more formal educational institution emerged. Most young individuals cannot learn to read and write on their own; nor can they handle more than the most elementary numerical totals and operations without some formal instruction and ample opportunity to practice, preferably with targeted feedback. With the rise of literate and numerate civilizations, fresh needs emerged, for locations called schools, and for adults—variously thought of as teachers, instructors, masters, models, coaches, or even tyrants—charged with the responsibility of educating the young. In the first centuries of schooling, the relevant learners were undoubtedly drawn from a relatively small population—the most promising male offspring of elite families. But in more highly elaborated civilizations, such as Imperial China, a formal examination system was set up. And at least in principle, talented males from different social strata had the opportunity to receive formal education and, ultimately, to become part of the ruling, managerial, or "mandarin" class.

The first schools existed for three primary purposes: to enable young persons to become literate and numerate; to inculcate in them the discipline of hard work, often carried out in settings remote from daily life; and to make sure that the principal religious and moral knowledge and values of the culture were transmitted to the elite who would, in the fullness of time, pass this lore on to succeeding generations. In the absence of officially designated courses, let alone schools of education, these educational milieus proceeded in a rough-and-ready way (with the emphasis on roughness). Through ceremonial rituals, often accompanied by sweets, young persons were enticed to enter the "house of learning." But once enrolled in schools, the regime was strict and unforgiving. Teachers ruled the roost. Students copied, memorized, and drilled. The rod was not spared. And except for a privileged few, formal schooling came to a predetermined end once the basic competences in literacies had been achieved and the student had shown that he or she was capable of obedience and informed about the major religious and social norms of the community.

Education in the Premodern Era

With the increasing division of labor in burgeoning civilizations, various specialties emerged. Those that were chiefly technical—tool making, shopkeeping, production of materials for daily living or of special objects for the elite—were transmitted primarily through apprenticeships, typically carried out in a quite unforgiving manner. In medieval Europe, these were institutionalized in craft guilds. In addition, however, specialties that were slanted toward the purely cognitive—astronomy, geometry, notated music, calligraphy, rhetoric, logic, copying and illumination of manuscripts, theology, and philosophy—also emerged in Buddhist, Christian, Hindu, Islamic, Jewish, meso-American, and other rising civilizations. These specialties required far more education than basic schooling. And it was for the inculcation of

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these specialties that lycees, universities, academies (including that ideal form described by Plato), and other institutions of higher learning emerged in the last two millennia.

Education in the Modern Era

Until the time of the Renaissance in the West (starting around 1400), most educational institutions around the world had a heavily religious patina. The leaders, the funding, and the curricula were dominated by the regnant theology, be it Catholic, Islamic, Jewish, or polytheistic. And except for a tiny elite, education typically stopped with the mastery of basic literacies as defined over the centuries. But with the rediscovery of the knowledge of the ancients (chiefly Greek and Roman), the rise of merchant classes, the exploration of the world beyond Europe and the Middle East, and, most importantly, the invention of printing, a slow but seemingly inexorable trend began toward the secularization and the universalization of education, at least for young people in the years before adolescence.

Accordingly, in most parts of the world, even today, the broad outlines of teaching and learning are strikingly similar to one another. Formal schooling begins at age five to seven; the preceding years include, at most, introduction to the forms of literacy, experience of working and playing with peers, and an inculcation of routine in a setting apart from the more familiar terrain of home, the streets, the playground, the open fields, or the forest/mountain/coast line. Formal preschools are a quite recent phenomenon, though they are becoming standard practice in several European countries.

In the early years of formal schooling, teachers—largely women—introduce students to reading, writing, and elementary arithmetic. This introduction is done in part by modeling and in part by imitation, with some oral recitation, and some exercises in workbooks or worksheets. There is increasing recognition of individual differences, including specific learning deficits. There may also be some adjustment in both curriculum and pedagogy for these varying constituencies. But by and large, the model followed is that of "uniform schooling." That is, there is a single way of teaching, a single way of studying and learning (chiefly copying and giving content back to the teacher), and a single way of assessing learning (through some kind of oral and/or written examination). Uniform schooling reflects both fairness and efficiency. It *appears* fair to treat all children in the same way; and it is also efficient, given classes of 20, 30, or even 60 charges in one room, sometimes arrayed by age, sometimes decidedly heterogeneous in composition.

In much of the world, schooling still ends with the mastery of the literacies. But in developed societies and in rapidly developing societies, preadolescents and adolescents are exposed to those subject matters or disciplines that are deemed most important for work and citizenship in the modern world. Almost everywhere, the curriculum features mathematics (algebra, geometry, and perhaps calculus or pre-calculus); science (with physics, chemistry, and biology the chief sciences); history or social studies (typically a focus on the history of the country or region, with a smattering of world history and culture and, possibly, some attention to current events); and in diminishing order of popularity, other sciences (e.g., geology, astronomy, social sciences like economics or psychology), geography, civics, physical education, and one or more art forms. In most societies, there is little attention to extracurricular activities (the United States, with its focus on sports, arts, publications, student government is an outlier here); budding scholars are expected to study hard, often aided by parents or by tutors if sufficient financial resources are available.

It would be an exaggeration to claim that formal education takes place without attention to what has been learned about the processes of successful learning, such as insights into student motivation, study habits, strategies, metacognition, and other approaches obtained from experience, or, more recently and systematically, from the psychological and cognitive sciences. But it would probably be accurate to say that such accumulated knowledge is used only spottily and sporadically in most parts of the world. Education—teaching and learning—changes very slowly. The texts, the teacher-dominated lectures, the stylized interaction between students and teachers, the examinations, the graduation requirements, are not that different from those that could have been observed a century ago. And given the previous changes in communication media—telegraph, telephone, radio, television, film, film strips—it is notable how little they have infiltrated into the core of the educational process. Whether the classroom and, more broadly, the learning process will prove equally

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unaffected by the new digital media—interactive and Internet-enabled technologies such as personal computers, mobile phones, game consoles, and the virtual spaces afforded by them—is open to question.

In most education around the world, the classroom is pointedly teacher-centric. The teacher is assumed to be the center, the fount, of all knowledge; the students are perceived as relatively empty vessels, into whom skills and information are to be deposited as efficiently and correctly as possible. Students are assumed to differ in native ability, and the purpose of school is to discover those destined to be quick learners, to give them the goods to advance, and to educate minimally, or even cut as losses, those who are not gifted in learning. The IQ test was devised as an instrument that could aid in this culling purpose (Gardner 1983; Gould 1981).

To be sure, counterthemes or counterforces have existed previously. Primary education has a strong strand, dating back to Pestalozzi and Froebel and culminating in Montessori, Dewey, and Malaguzzi, that emphasizes hands-on learning and the construction of knowledge by the child. Relatedly, though not identically, there has been recognition that not all children learn in the same way or benefit from the same kind of educational milieus. Progressive educators in Europe and the United States have tried, with some success, to draw on these ideas for later education (Aikin 1942; Bruner 1960, 1995; Cremin 1988; Dewey 1998, 2004). Yet, nowhere are these ideas dominant. Indeed, until today, one might say that the European classroom models of the 19th century continue to hold sway: Teachers give out information, students are expected to master it with little help, and the awards of the culture during the years of school go to those who can crack the various literate and disciplinary codes.

Over the course of a century, the major differences in teaching and learning can be summarized as follows:

l. Education is increasingly universal. Except in the undeveloped world, almost all boys and most girls get an education at least to the secondary level. The diversity of the student body is devious.
2. The hegemony once occupied by humanities and language is increasingly replaced by subjects related to STEM—science, technology, engineering, and mathematics.
3. In addition to the increasing nationalization of curricula (almost everywhere except the United States), there is growing focus on performance in the so-called international comparisons, especially the TIMMS and the PISA tests.

Looking Forward

Learning in a Postmodern, Digital Age

While the broad changes in education noted above are not insignificant, they have not dramatically impacted the nature of learning in many schools; the content, functioning, and organization of the typical European classroom model remains relatively unaffected despite major transformations in the world just beyond its walls, and the implementation of more meaningful changes remains stalled. In sharp contrast to the stasis of the classroom model, important changes proliferate in the world. To name a few, our global civilization must address climate change, the revolution in the understanding and use of genetic information, other biomedical breakthroughs, the power and ubiquity of financial markets, the exploration of space, nuclear power and nuclear weapons, massive immigration, and the emergence of powerful new communication media. Both the demands of the workplace and the demands of education have changed profoundly and promise to do so for the foreseeable future. This scientific and cultural environment, in which the products of technologies have jolted long-accepted notions of time, space, and nationhood, is known variously as “postmodernity” (Lyotard 1984), “hyperreality” (Baudrillard 1994), “late capitalism” (Harvey 1989; Jameson 1991), “risk society” (Beck 1992), or “high modernity” (Giddens 1991).

Of particular relevance for learning is increased skepticism and contestation of what constitutes “truth.” In the view of many commentators, the collapse of metanarratives (Lyotard 1984) and a heightened awareness of the limitations of language (Derrida 1998; Wittgenstein 2002) have rendered truth as a fluid entity validated primarily by consensus. In the absence of recognized authorities and standards for determining what is considered true, learning is problematic. This postmodern perspective is not universally shared. Many continue to operate in a climate in which facts are fixed entities taken for granted, information is created and circulated relatively slowly, and authority figures are invested

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with the responsibility of determining and sharing what is considered true and good. Even so, it is undeniable that new opportunities for individuals to assert the truth, or their truths, are afforded today; educators will likely grapple with questions about what is true, and what is worth teaching and learning, more and more, both now and in the future.

It seems improbable that the traditional educational model is capable of serving the needs of a transformed culture and a population that is growing up in radically changed milieus. The prospect of how education might change (based on how one could learn) has engendered a dynamic discourse, with scholars and researchers volunteering different sets of prescriptives—skills, curricula, and the like—to better align the educational system with contemporary challenges and opportunities.

Critical Skills for Today and Tomorrow

Many educators have attempted to categorize what, in this changed environment, constitutes necessary skills across a variety of developmental levels: Murnane and Levy (1996) promote "hard skills" (math and reading), "soft skills" (collaborative and social skills), and computer skills as a way to secure middle-class jobs; Gardner (2007) identifies the disciplined, synthesizing, creative, respectful, and ethical minds as "five minds for the future." Many others propose future skill sets: "seven survival skills for teens today" (Wagner 2008); the right brain–themed "six sense" (design, story, symphony, empathy, play, and meaning [Pink 2005]); the "four outcomes" (core subjects and 21st-century themes, learning and innovation skills, information media and technology skills, and life and career skills (Partnership for 21st Century Skills 2007), to name a few.

In these frameworks, the traditional "three R's" remain but are supplemented by a broader focus on metacognitive skills and an acknowledgment that individuals live in a complex world defined in part by existing but fluid frames of meaning (Geertz 1993). Most would agree that a well-educated individual should be able to successfully participate in a global economy where money, culture, ideas, and people circulate rapidly; to synthesize and utilize vast rivers of information obtained through a variety of channels (textual, visual, multimediated); to engage with this information across a variety of disciplines; to be comfortable negotiating a range of social connections, including interacting with diverse populations; and to serve as an engaged and responsible member of one's profession and one's communities.

Digital Cultures

The new digital media (NDM) are implicated in many of the broad changes underway and underscore the importance of the aforementioned new skills. Digital media allow for nearly ubiquitous access to people and to virtually infinite amounts of information, as well as affording new forms of sociality, play, creativity, social activism, networking, and collaboration. It is important to acknowledge that access to digital technologies is inequitable. Despite significant progress in bridging the "digital divide" over the last decade, most of the world's populations are offline; only 5.3% of Africa's population can use the Internet, compared to North America's population, of which 73% are Internet users. In the developed world, the relatively privileged enjoy access to digital media tools and resources. North America boasts the largest rates of Internet penetration, but the statistics do not elaborate on the range of Internet experience for those who have access, from the fully wired, robust, and easily accessible home computer to the censored and shared access offered by the local library or Internet café. Twenty-seven percent of North Americans remain offline either by choice or by circumstance (all statistics from World Internet Uses and Population Stats 2008).

We acknowledge that attempting to draw any generalizations relating to NDM are problematic, as engagements with NDM vary widely across economic, ethnic, and social cohorts. Assumptions are frequently made about the digitally savvy, especially with respect to age: It is the younger generation who are often accorded such labels as "digital youth," "digital natives" (Palfrey and Gasser 2008; Prensky 2001), "neomillenials" (Dede 2005), and "net generation" or "net gen" students (Oblinger and Oblinger 2005). These labels have been contested by scholars who point to the variation in access and digital skills among youth on the one hand, and the age variation among the digitally savvy on the other (Jenkins 2007; Palfrey and Gasser 2008; Vaidhyanathan 2008). Leslie Johnston, affiliated with the Library of Congress, writes of working with a diverse range of technology users, including technically savvy sixty-something faculty members, middle-aged librarians who both

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reject and embrace new technologies, and "students at…research universities who could not care less about being digital" (Johnston 2007).

That said, we must also acknowledge that many American youth are introduced to digital media at relatively young ages and spend more time engaging with digital media at critical developmental stages than their older counterparts did. While adults as well as youth use NDM to build upon existing social links (Kennedy et al. 2008), the average teen spends approximately 11.5 hours a week of his or her free time creating, exploring, playing games, and communicating online (ConsumerLab 2008); over half of teens age 12–17 use a social networking site; approximately three out of five teens upload some type of creative content online (Lenhart et al. 2007); and virtually all teens engage in some type of video gameplay (Lenhart et al. 2008). The online practices of teens vary dramatically; they may be avid texters and emailers, social networkers, casual surfers, and news browsers, or deeply invested MMORP gamers and social activists.

The meaning of this teen engagement with digital media is widely contested. Critics lament the decline of literacy, divided attention, and the decline of autonomy, among other concerns (Bauerlein 2008; Keen 2007; Turkle 2008; Wolf 2007), while enthusiasts laud the social and intellectual skills cultivated in games, virtual worlds, and online communities (boyd 2007; Gee 2003; Jenkins et al. 2006; Shaffer 2006). The net impact of youth digital engagement remains to be seen. In the subsequent section we describe the ways in which the growing prevalence of digital media in young people's lives—and the powers of these media in and of themselves—may hold the potential to occasion a decisive tipping point with respect to long-standing modes of K-12 learning and education, as well as lifelong education.

New Digital Media Affordances

While technology is often cited as a primary driver of cultural change, we recognize an iterative relationship among individuals, the technologies they use, and their cultural practices, with each informing and shaping the other. We similarly acknowledge that the term "new digital media" does not represent a single unitary entity; rather it encompasses diverse hardware, software, and technologies—a "digiverse" defined primarily by the ease of circulation of digitally based materials and communication.

We align ourselves to an intellectual tradition that sees people, their ideas, and technologies as intertwined in dynamic systems or dialectical relationships (Callon 1986; Latour 1987; Scribner and Cole 1978, 1981; Smith and Marks 1994; Williams 2003; Winner 1977). We do not consider ourselves technological determinists—we acknowledge that technologies (including all forms of media) are created in social contexts and through social relations. Once created, technologies have social impacts, but no technology in and of itself has ineluctable consequences. At this point in their proliferation, much remains unknown concerning the educational and learning impacts of NDM: Will they be large or small, will the outcomes be positive, negative, mixed, or neutral? It is still too early to tell.

That having been said, we believe that a "perfect storm" of NDM affordances, sociocultural changes associated with globalization, and the growing pace and interconnectedness of human life may potentially add up to a formidable tipping point. We operate on the assumption that NDM contain affordances that, if leveraged properly, could create future learning environments and cultures in which the promises of constructivist, social, situated, and informal learning are realized. We recognize that we could be wrong. We also recognize—and will elucidate at critical points—how the integration of NDM practices into a school setting can be challenging, such as the difficulties of implementing more social-based Internet practices in the classroom, or of incorporating youth's extra-curricular, digital pursuits into fruitful classroom instruction, for example.

In the discursive pairs outlined below, we profile the positive and negative NDM affordances as they relate to contemporary learning strategies and the ways in which they can support, or thwart, the cultivation of the new skills we believe to be important today.

Informal Learning as a Complement to School-Based Learning

Traditional learning employs a mechanical model of "one curriculum fits all" under the guise of fairness and efficiency. Critics have argued that such a "uniform system" is arguably unfair to those students with different learning styles or intelligences; while it may be efficient, it is unclear that this approach is particularly effective in the context of universal schooling. In digital environments, different

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options or pathways to understanding—textual, visual, game based—may be readily available in keeping with principles of "universal design for learning" (Rose and Meyer 2002).

While the ubiquity of digital media resources allows for more customized learning within a formal learning context, its primary value lies in the acknowledgment of the legitimacy and value of learning that take place beyond formal schooling. While the concept of informal learning has been acknowledged for decades (Tough 1979), its definition varies across contexts including the home, the playground, the afterschool setting, and even the school setting as well as through various mediated sources of information. In a review of the literature on informal learning with technology outside of schools, Sefton-Green defines the difference between informal and formal learning as based on "the intentions and structure of the learning experience" (Sefton-Green 2006, p. 6). One could argue that a strictly formal learning experience is characterized by classroom-based instruction featuring an explicit curriculum and traditional pedagogical goals, and scaffolding implemented by a single educator; a pure informal learning experience lacks all of these characteristics. While these extremes help to define the argument, multiple hybridic forms of pedagogical practice located on a continuum between formal and informal, which combine elements from both approaches, are more the norm.

In a postmodern, globally interconnected, digital world, individuals will likely be required to master new technologies and related behaviors throughout a lifetime to successfully learn, synthesize, and adjust to rapidly shifting requirements of the workplace and the culture. "[A] capacity for independent learning," suggests Brown, "is essential to [students'] future well-being, since they are likely to have multiple careers and will need to continually learn new skills they were not taught in college" (Brown 2006, p. 18). Others argue that informal learning can harness learners' passion related to the activities they voluntarily engage in, and capitalizes upon the collective power of group, rather than individual, endeavors (Ito 2008; Jenkins et al. 2006), with the Internet providing opportunities for self-study and self-directed learning for all, while schools increasingly do not—indeed cannot—handle the burgeoning educational requirements of a growing, ever more diverse population.

Informal NDM activities commonly undertaken by youth include independent investigations of topics of interest (sports, news items), participation in online communities, writing a personal or topical blog, content creation (video, music, art), and gaming. The learning potential within games may be viewed by some with skepticism (Bauerlein 2008), but video game researchers credit games with invoking and nurturing key competences (Gee 2003; Shaffer 2006). Valuable metacognitive skills, or "new media literacies," can also be nurtured through online engagements (Jenkins et al. 2006). As evidence grows concerning the competences gained through these activities, traditional notions of school as the ideal locus of the full range of learning may be disrupted.

Whether the potential of such informal learning experiences can be achieved either to complement or augment formal learning remains unclear. A core pedagogical challenge for informal learning is the learner's ability to apply lessons learned in one context to related (and even unrelated) contexts; this is the classical educational issue of transfer. For informal learning to augment, or even in certain instances replace, formal learning, measures of its quality and its (real or potential) transference to other contexts will need to be more firmly established. One strategy might involve formal education playing a role in informal learning spaces (perhaps on the analogy of teaching hospitals), and learners' out-of-school passions finding a validating place in formal educational arenas. However, students may resist the cooptation of their free play by teachers bent on measuring its impact; teachers may similarly resist the introduction of unorthodox materials into the classroom. Should strategies be crafted for assessing the quality of learning in informal environments, helpful criteria might be found among the features of constructivist learning.

Constructivist Approaches Replace Didactic Learning

In the traditional classroom, a teacher distributes text-based materials and augments them with oral information; lessons are reinforced through notetaking, homework, and textbook guides. Knowledge is possessed by the educator and imparted to his or her students in a top-down, unidirectional transfer, and a student's classroom success or failure is assessed by said educator (or by an externally mandated examination). Constructivist epistemologies redefine existing pedagogical roles, eliciting more engagement and

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investment on the part of the learner, and less overt control and knowledge dissemination on the part of the educator.

NDM's vast resources, including the provision of many activities in which the user assumes a formative role, can complement constructivist approaches to education. As noted above, a motivated learner can investigate a wide variety of personal interests on his or her own. Or potentially, he or she can learn sophisticated analytic and social skills by playing complex games or participating in a social network or online forum, entirely independent of formal educational experiences or designated instructors.

Various research groups are currently developing user-driven applications such as the semantic web, affective computing, and other such variants that will react to user input in real time and be able to assess the developmental or cognitive levels of the user (Chen 2008). Our research has shown that students today may have the resources to be more informed about global events such as the Darfur genocide or the plight of Romanian orphans—interests prompted by school content or peers, and by the availability of information online—than they have been in the past.

Most schools have already invested in the necessary infrastructure upgrades to allow some level of Internet access, and are able to take advantage of these pedagogical opportunities. However, there are serious challenges associated with implementing an NDM-based pedagogy. NDM may be seen as sources of entertainment and escape, not learning; additionally, the determination of the proper level of scaffolding can be difficult.

The Internet's potential for learning may be curtailed if youth lack key skills for navigating it, if they consistently engage with Internet resources in a shallow fashion, and/or if they limit their explorations to a narrow band of things they believe are worth knowing. Left to their own devices and without sufficient scaffolding, student investigations may turn out to be thoughtful and meaningful—or frustrating and fruitless. A successful informal learning practice depends upon an independent, constructivistically oriented learner who can identify, locate, process, and synthesize the information he or she is lacking. More specifically, a variety of cognitive limitations, along with features of current search engines, problematize the identification, depth, and assessment of online searches for the typical student (Guinee 2007):

Identification: The number of information sources available can be overwhelming and potentially paralyzing to information seekers, a problem identified by Schwartz (2003) as "the paradox of choice." Depending on the developmental and intellectual sophistication of the learner, such a virtually unlimited range of choices may be liberating, confusing, or frustrating.

Depth: Current research suggests that when young learners do dive deeper for information online, their search skills are typically lacking. They are prone to drift off-task as they become distracted by tangential material and fail to return to their original search thread (Palfrey and Gasser 2008). What is known about the browsing habits of youth and adults suggests that "searchlight" techniques—browsing for surface information to get a general feel for a subject—are more typical than focused "laser beam" searches (Palfrey & Gasser 2008; Rowlands and Fieldhouse 2007). In an information-saturated environment, skimming is a critical skill; however, learners drawn to superficial content may be less able to sustain a directed focus, assess findings, and reflect upon the meaning and significance of rapidly encountered information.

Assessment: Students trained in traditional media literacy curricula (i.e., those based on books, advertising, television, film) may or may not apply these skills to online sources (Metzger et al. 2003). As one educator whom we interviewed noted, "Kids are taught media literacy skills, but then they go online and they are dazzled." Youth interviews we conducted demonstrate that a link listed as Google's top result is all too often interpreted as a credible marker for information sources. The growing presence of commercial interests behind or alongside content is particularly problematic in this regard.

The Internet may assist in narrowing perspectives if an individual chooses to engage with a single line of reasoning or point of view with limited, superficial exposure to contrasting information (Bishop 2008; Sunstein 2007). Defined by some as the problem of "balkanization" online, unscaffolded

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Internet engagement may allow users to self-select information that further refines, or shrinks, one's worldview.

Educators tend to frame NDM as either entertainment devices or as tools to simplify administrative tasks such as locating images or reading papers (Developing Minds and Digital Media Project 2008). The sustained popularity in the classroom of "skill and drill" software packages that mimic repetitive offline practices suggests that the tools, actors, and culture of the typical classroom are not yet aligned to support the more constructive pedagogical approaches facilitated by NDM. At this point in time, deeply constructivist classrooms remain few and far between despite evidence that hands-on, problem-solving approaches in the classroom result in higher levels of student engagement, conceptual thinking, knowledge transfer, and retention (Scardamalia, Bereiter, and Lamon 1994; Bransford et al. 1999; Hmelo-Silver 2004; Meier 1995; Project Zero and Reggio Children 2001; Sizer 1984). But in an environment of "No Child Left Behind" and standardized tests linked to federal funding, the implementation of constructivist principles in the classroom can be considered a risky enterprise for public schools.

Opportunities for Contextualized Learning

Before the advent of classroom education, most learning was contextualized by default; the apprentice learned metalsmithing from the journeyman in his workshop, the daughter learned weaving from her mother in or near the home. The classroom model of a shared room equipped with books that held the keys to learning was a radical departure from the apprentice model of one-to-one learning and onsite knowledge transfer.

Recently, renewed attention has been paid to situated or contextualized learning—the contention that learning cannot and should not be separated from relevant physical and social contexts (Lave 1985; Lave and Wenger 1991). In contrast to mainstream classroom approaches, immersive technologies such as virtual worlds, augmented reality games, massive multiplayer games, social networking tools, and knowledge and fan communities offer highly active, situated, and social learning experiences. Engaging recreations of complex historical and present-day events may engender more enduring or nuanced understandings and, when framed as games, perhaps deeper investments in learning. For example, *Quest Atlantis* and *River City* and serious games such as *Darfur Is Dying* engage participants in quests in which learning about science, the environment, and global political issues are integral to the game (*Darfur Is Dying* 2008; *Quest Atlantis* 2008; *River City* 2004). Traditional teaching approaches to such topics are more abstract and less engaging; these approaches may have worked well for some learners, but not for others.

Virtual learning environments offer diverse pathways to understanding, thereby accommodating individual intelligences and learning styles (Dede 2005; Gee 2003; Jenkins et al. 2006; Rose and Meyer 2002; Shaffer 2006). Games and software tools such as *LittleBigPlanet*, *Gamestar Mechanic*, *Stagecast Creator*, and *Scratch*, which invite and scaffold youth in the design of their own games, take these affordances even further (*Gamestar Mechanic* 2008; *LittleBigPlanet* 2008; *Scratch* 2008; *Stagecast Creator* 2008). *Second Life*, the massive multiplayer environment, offers a buildable environment for online interactions that straddles gameplay and virtual reality; *GoogleEarth* allows users a bird's eye view of the world (*GoogleEarth* 2008; *Second Life* 2008). A Montana State University professor has incorporated these tools in his architecture courses, where his students can now manipulate simple 3D shapes and import digital models into dynamic models of the world (Kieran 2007).

Mobile tools such as handheld computers or similar portable, sophisticated appliances have the potential to free students from the classroom context and immerse them in rich, meaningful learning experiences while maintaining access to text- and graphics-based learning supports. These types of mobile media, or "augmented reality," provide unique educational affordances, including portability across multiple sites, social interactivity, context-specific engagements, connectivity that can capitalize upon the resources of a network, and a unique experience for each individual learner (Klopfer et al. 2002). The teams of students who play *Environmental Detectives*, for instance, investigate a virtual chemical spill in the real world by collecting data and interviewing experts, witnesses, and suspects via a handheld device. In Waag Society's *Frequency 1550* game, students are transported back to a historical Amsterdam to search for a lost relic—all courtesy of their mobile phones (*Frequency 1550* 2005).

A major concern for augmented contextualized learning is the question of impact, particularly with respect to computer-generated environments. To what extent is a screen-based simulation, which

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limits tactile input to two of the five senses, a legitimate substitute for a real world version? Would we fly with a pilot or have surgery by a physician who has learned only on a simulator? In other words, what might be lost if simulations entirely replace real, high stakes learning by doing (Gardner 2006)?

There is also the challenge of trying to focus the attentions of a group of children of various maturity levels and temperaments within novel physical or virtual environments. To what extent might a contextualized setting function as a distraction or a hindrance to learning? What are the merits of traditional classrooms in this regard? Familiarity and comfort with the environment of the usually age-graded classroom may allow a student to focus on the less familiar and often challenging tasks at hand. The school is usually the first place in which a student is expected to heed the directions of an adult not in his or her family, to sit still and to behave in a socially appropriate way, and to learn about important matters that are not within the current frame of reference—all skills that are still valued in an adult as he or she progresses through life.

And, finally, situated learning with NDM suffers from the same difficulties associated with formal assessments as do many NDM learning initiatives. In order for NDM to help students move out of the classrooms and into the world, educators need to carefully consider how to establish baselines for assessing progress in unorthodox settings with little or no precedents, and how to grade students on the basis of their activities in these types of settings.

Supports for Social Learning

In a traditional classroom, each student is regarded as an independent and separate entity with his or her own desk, books, assignments, motivations, assessment, and grades; progress is evaluated in light of the student's record of individual achievements or failures. Students who engage in group work as part of their training are likely to be better prepared for the networked, globalized marketplace than those who do not (Brown and Duguid 2002; McConachie et al. 2006; Murnane and Levy 1996; Wenger 1998). In recent decades group work has become increasingly prevalent in schools as well; well-organized classroom group work can both engage students and assist the teacher in classroom management (Cohen 1994; Johnson and Johnson 1975; Slavin 1983).

Digital technologies offer new ways for students to engage in social learning. Enthusiasts point to the virtues of fully wired learning spaces that enable ongoing dialogue (back-chat) during lectures, polling of students, instantaneous sharing of ideas and work in progress, and immediate access to the Internet's knowledge communities (Vogt and Mazur 2005). The potential also exists to extend this model through long-distance collaborations, distributed cognition projects, and collective intelligence work. A web-based project at MIT, for instance, paired French language students with peers in France learning to speak English, and provided students an authentic opportunity to practice their language skills, learn online communication skills, and negotiate the implicit guidelines of a different culture (*Cultura* 2007).

In the current era, communities in which knowledge is forged by consensus—the "wisdom of crowds" (Surowiecki 2004)—are growing in number, facilitated by digital media's collaborative, networked capacities. As Shirky most recently notes, the new tools of "social media" create unprecedented opportunities "to share, to cooperate with one another, and to take collective action, all outside of the framework of traditional institutions and organizations" (Shirky 2008, p. 21).

These affordances also carry discernable risks. Voices of dissent may not be heard or, perhaps worse, shouted down by the majority. "[T]he power of the majority…[is] not only preponderant, but irresistible," cautioned Alexis de Tocqueville in his classic treatise *Democracy in America*. "The moral authority of the majority is partly based upon the notion that there is more intelligence and wisdom in a number of men united than in a single individual" (de Tocqueville, 1899). However, history teaches us that too often the majority opinion is driven by factors other than rational discourse and honest debate; we note that the concept of the mob is being reframed as a smart or wise agent of change (Rheingold 2003; Surowiecki 2004) in contrast to the traditional definition, "a riotous or disorderly crowd" (Oxford English Dictionary 2000). NDM social learning activities need to be actively monitored to ensure that everyone has an equal chance to participate, and that colleagues treat one another with mutual respect.

Collaborations can also be difficult to maintain; common pitfalls include conflicts over intellectual property (IP) rights, competition trumping collaboration, unclear directives, and trust and personality

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issues (Leslie 2006). Online collaborations in which the participants are otherwise unknown additionally struggle with temporal delays, which can lead to misunderstanding and a tendency to blame some remote "other" for difficulties. Walther and Bazarova (2007) found that the most successful online collaborative groups were longer-term projects in which participants had shared expectations concerning response time, and were physically located in the same regional geographical area.

A group's structure and its form of participation—elective or mandatory—will also influence its functioning, endurance, and value for individual participants. With voluntary associations, the ease with which an individual can join or leave a group depends largely upon the strength of ties within the community itself as well as his or her level of investment in it. Although the leader of a raiding party in *World of Warcraft* can, technically, stop playing at any time, many players would be adversely impacted by the leader's departure; conversely, community participants of a DIY site such as *Instructables* may collaborate offline, but a community member's departure would not significantly impact the site experience itself (*Instructables* 2008; *World of Warcraft* 2008).

The social dynamics of a group, and demographic characteristics of members, may affect its potential as a learning collective. Research suggests that students enjoy engaging in group tasks because it enables them to socialize more with their peers; it can be a challenge to keep adolescents in particular—developmentally highly social and self-conscious—focused on tasks when they would prefer to just hang out with friends. The gender of digital participants has also been found to affect collaborative learning practices: As they mature, girls may not want to publicly demonstrate technological fluency for fear of appearing "weird" or violating gender roles. Girls and boys employ different strategies as they pursue investigations, with boys more likely to assemble data and girls more likely to conduct interviews (Klopfer and Squire 2008, p. 218).

In a broader cognitive sense, there may be risks associated with learners and learning distributed across real and virtual spaces conducting the vast majority of their learning through devices. The current extent of multitasking and the phenomenon of continuous partial attention associated with 24/7 engagement with digital devices needs to be acknowledged (Stone 2008). Turkle suggests that the fact that we can be, and increasingly are, always connected to one another through digital devices has somewhat unsettling implications for how we think, feel, and understand ourselves and others. "Adolescents naturally want to check out ideas and attitudes with peers. But when technology brings us to the point where we're used to sharing thoughts and feelings instantaneously, it can lead to a new dependence…and what of adolescence as a time of self-reflection? [Texting and instant messages] are not intended to open a dialogue about complexity of feeling" (Turkle 2007). A student's persistent connection to others may undercut opportunities for reflection, synthesis, and integration of knowledge as we increasingly rely on each other for what we need to know. If not used judiciously, digital media may over time undermine personal autonomy rather than enhance it.

Conclusions: Implications for Education as We Know It

In this article, we have argued that the contours of learning—what is deemed important to learn, and where, when, and how—evolve over time, albeit at times very slowly. Remarkably few significant changes in teaching and learning have occurred since the onset of the modern era, despite broad and deep changes that arguably amount to the rise of a postmodern, globally interconnected, and digital world. We have highlighted the new digital media as a powerful facet of these changes; these media carry affordances that could foment further shifts (for both good and bad), particularly in relation to learning.

The new digital media provide new ways of engaging with each other, with information, and with the world; we have pointed to both promising and problematic implications of these affordances. Ultimately, we believe that digital media could be leveraged in ways that bring about a tipping point when learning becomes more decidedly individualized, constructivist, situated, and social. Again, the paradoxical confluence of opportunities for individualized *and* intensely social learning experiences is a noteworthy facet of digital media. It is far from clear who understands, takes seriously, and—importantly—is poised to act upon these potentials. While talk of reform is everywhere, far too much of the discussion centers on test scores in traditional subjects, secured in traditional ways.

The question of whether learning should take place in radically different ways—in terms of content,

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pedagogy, and assessment—is likely to become urgent in the very near future, in part because young learners themselves may be different from prior generations in their learning orientations; if so, these differences are arguably related to their increasingly digital lives. The question of the role of schools and teachers vis-à-vis digital cultures is particularly urgent. Schools cannot afford to ignore, nor simply attempt to curtail, students' uses of digital media for several compelling reasons.

First, youth are engaging with digital media at ever-younger ages (Rideout et al. 2003). Students walk into classrooms (even toddle into preschools) armed with new competences, learning preferences, and expectations that call into question existing curricula. Indeed, there is mounting evidence that the learning preferences and styles of youth are affected by their digital engagement. Dede argues that "people's daily use of new devices is shifting their lifestyles toward frequent mediated immersion, which in turn is shaping their learning styles" (Dede 2005, 15.12) toward "neomillenial" characteristics. These new learners are described as "more active based on real and simulated experience," visually oriented, self-reflective, social, fluent in multiple media, adept at navigating diverse information sources, and appreciative of co-designed learning experiences that are personalized to individual needs and preferences (Dede 2005, 15.15). Others describe "net gen" students as adept multitaskers, who are "social and team-oriented," and geared toward "a hands-on, 'let's build it' approach—all encouraged by the IT resources at their disposal" (Brown 2005, 12.2; Oblinger and Oblinger 2005).

These observations suggest that many students today are using digital media in ways that might lead them to question approaches that are more teacher-centric, uniform, and passive for students. Again, these labels ignore both the "digital divide" (unequal access to technologies among youth) and the "participation gap" (unequal access to the opportunities, experiences, skills, and knowledge that will prepare youth for full participation in the world of tomorrow [Jenkins et al. 2006]). Not all youth exhibit the "neomillienial" traits described above. However, the trends being observed among some students are worth paying attention to, especially as larger efforts are undertaken to narrow the divides and gaps among youth. The world as a whole is increasingly wired, and we are charged with preparing our youth to face the challenges of the future. Success in that endeavor will remain elusive until we teach them to weather the challenges of the present.

Second, as exciting as these new facets of learning are for supporters of constructivist, situated, and group learning, the mixed potentials described in the "Looking Forward" section of this article must be acknowledged. Educational institutions are important stakeholders for cultivating the promises but also helping to counter the risks associated with these trends. For example, while young people may be comfortable with, and even enjoy, navigating the volume of information yielded from a typical Google search, their assessments of what is reliable and trustworthy may be weak (Guinee 2007; Palfrey and Gasser 2008). Formal schools have both a stake in—and are well poised to scaffold—good assessments and syntheses of information (Gardner 2007). Understanding informal learning should arguably be on the agenda for schools, too. Should informal learning spaces continue to grow in importance, it seems that a role for schools and teachers may be warranted—perhaps if only to provide their students with scaffolding so that they can properly acknowledge, assess, and (ideally) transfer learning to other contexts.

The advent of digital media and their affordances—particularly those related to the emergence of potentially new learning styles and the explosion of informal learning communities online—constitutes clear pressures on educational institutions to acknowledge them in some fashion. If schools do not take seriously the positive and negative potentials of digital media for learning, they risk becoming increasingly irrelevant to the lives students lead outside of school and to the futures for which they are being prepared. In thinking about the future, Perkins (2008) argues that our attention should be directed to the growing "relevance gap" in education today—the failure to teach things that have a good chance of being relevant in the uncertain future. As we've noted, successful and fulfilled individuals, workers, and local and global citizens in the future will need new kinds of competences ranging from information synthesis to social skills to the cultivation of an ethical mind. Of special importance is the capacity to draw on various disciplinary skills in order to tackle problems that by their nature entail multiple disciplinary perspectives. Schools themselves have little experience in doing this, at least before the years of higher education; it is difficult to see how they can meet this challenge without judicious use of the new digital media (Gardner 2007).

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Very few schools have risen to the challenge of remaining relevant; most have hardly progressed beyond the models in place a century ago. What might it take for slow-to-change schools to embrace the potentials, and deftly manage the risks, associated with digital media and cultivate broader competences for the future? With respect to digital affordances in particular, perhaps surprisingly to some, access to technology per se is not the panacea. As Christensen (2008) documents, the over $60 billion that schools have invested in technology over the past twenty years has had little discernible effect on pedagogies or learning outcomes. He argues that only disruptive innovation—adopting digital learning wholesale—will change education. This disruption is most likely to emerge in places where traditional ways of teaching are outright failing; over time, Christensen says, educators and the general public will come to see the potential of powerful, individualized, and connected forms of media. Other studies of school change suggest that for systemic change to be widely adopted and successfully implemented, innovations must be at least somewhat familiar to stakeholders, and presented as a coherent system (Ellsworth 2004). Informed and skilled leadership is obviously essential as well (Fullan 2007).

Part of the answer to change surely lies beyond the walls of schools themselves. Parents, government, the professions, even the marketplace, are all important stakeholders in the state of learning. Alignment among these diverse constituencies may be hard to achieve; here political leadership of the highest order is essential. In the last few decades, the phrases "learning communities," "lifelong learning," and "the learning society" have virtually become clichés. Yet like many clichés in education, and elsewhere, the terms themselves are more familiar than actual instances of the phenomena they describe. In our view, no society is likely to thrive in the future unless it actually is dedicated to lifelong learning; and this, in turn, will require both a society that values learning, and communities that continue to learn. As educators, we hope that this learning will continue to take place in educational institutions. But unless the schools are equal to the task of absorbing the new digital media, and making acute use of their potentials while guarding against their abuses, schools are likely to become as anachronistic as almshouses, teachers as anachronistic as barber-surgeons. Any culture that wishes to survive will ensure that learning takes place, but the forms and formats remain wide open.

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